

Reference No.: 13  
Barite Hill/Nevada Goldfields  
HRS Documentation Record  
EPA ID No. SCN000407714

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**NEVADA GOLDFIELDS INC.  
BARITE HILL PROJECT**

**RECLAMATION PLAN UPDATE  
MINING PERMIT NO. 852  
CONSTRUCTION PERMIT #16,225**

**January 1992**

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## 1.0 INTRODUCTION

### 1.1 GENERAL

Nevada Goldfields Inc. operates the Barite Hill gold mining project in McCormick County, South Carolina. The project consists of two small open pit mines; Main and Rainsford, a mine waste disposal area; Area A, a heap leach facility which consists of an asphalt-lined reusable pad, and a planned permanent leach pad, a storage facility for rinsed-spent ore; Area C, solution ponds, and a process plant to recover gold from the leach solutions.

The current and planned leach pads, ponds, and process facilities are designed as a closed-loop circuit (or closed system), and will have a net water consumption requirement while operational. Operating plans and associated water balance calculations, demonstrate that the process water can be retained onsite and ultimately consumed by a combination of retention within the rinsed ore and evaporation. Consequently, no treatment facilities for solution discharge are incorporated in the operating process facility design. However, studies are ongoing in the event that some form of waste water treatment, or alternative system is employed to expedite ultimate closure. This is further outlined in Section 3.6 and Appendix A.

The project was commissioned in January 1991, based on the current ore reserve, mining will be concluded at the end of 1994, leaching and rinsing will be concluded in 1995. Closure is scheduled to be completed in 1996.

The reclamation plan herein presented is based upon the project plan as of December 1991. Additional exploration, mining experience, commodity price changes, or any number of other factors may alter the sequence of operations or reclamation.

This plan is submitted as a supplement to the Reclamation Plan submitted on Form MR-500, 4-5-89, Exhibit D.

### 1.2 SCOPE OF REPORT

The reclamation plan is divided according to the principal features disturbed as a result of the mining operation. Rinsing of the leached ore, wetland reclamation, revegetation, and closure monitoring are covered as general topics applicable to the entire project.

### 1.3 DESIGN CRITERIA

The goal of the reclamation planning is to stabilize

areas disturbed by mining operations and to restore a productive and self-sustaining vegetation cover. The site will be left in a safe condition with protection of natural resources. The proposed land use after completion of mining operations is as a grassland, since this is the most practicable vegetation type that can be re-established.

## 2.0 SITE DESCRIPTION

The project site is located in McCormick County, about three miles south of McCormick, South Carolina. It is located along a topographic high area in the headwaters of an unnamed tributary which drains into Hawe Creek.

### 2.1 TOPOGRAPHY

The project site lies along a ridge above tributaries to Hawe Creek. The average elevation along the ridge is about 480 ft, with elevation of about 510 ft being the ridge high point, and elevations along the Hawe Creek tributary on the northern boundary of the site at about 400 ft. The surrounding topography is comprised of rolling hills with the ridgelines at about elevation 500 ft.

### 2.2 VEGETATION AND WILDLIFE

The site is generally a wooded area with a mixture of second growth pines and hardwoods. About 52 acres along the mid to western end of the ridgeline were recently clear cut for lumber production.

The site is not within the boundaries of any areas designated as "Wildlife Management Areas" by the State Wildlife and Marine Resource Agency.

Wildlife and vegetation studies for the site which were completed as part of the environmental baseline studies were previously submitted (Dames & Moore 4-10-89, ETE 9-15-89).

### 2.3 CLIMATE

The project is located in a region of moderately high precipitation. Based on data collected from regional weather stations, the annual precipitation and evaporation are 47 and 46 inches respectively.

### 2.4 LAND STATUS

The land holding consists of nine tracts totalling 1,619 acres. The entire tract consists of fee land, no federal lands are impacted by the project. The actual affected land

from the mining operation is estimated to be 127 acres.

## 2.5 SURFACE HYDROLOGY

The most significant surface drainages at the project site are two tributaries to Hawe Creek. One perennial tributary runs along the north side of the site and by visual observation contains the highest flow. The second tributary starts on the south side of the site and then drains northward along the west side of the site, and appears to be ephemeral. The confluence of the two tributaries is about 200 feet northwest of the overall property boundaries. An intermittent creek is on the east side of the site.

The site is along a southwest-northeast oriented ridge with no creeks through the site. Surface runoff from the site is directed to the drainage described above. Most of the site acreage drains into the Hawe Creek tributaries to the south and west as described above.

## 2.6 GROUNDWATER HYDROLOGY

To date no groundwater has been intercepted above the limits of the proposed mine pits. Based on data available, the groundwater level is estimated to be at about elevation 380 to 400 ft or lower.

Detailed discussion of the site groundwater hydrology is included in the Rinsed Agglomerate Disposal Facility, Final Design Report, ETE 3-90.

## 3.0 RECLAMATION DESCRIPTION

As of January 1992, including the main access road, a total of 97.4 acres were disturbed. Current planning calls for a total disturbance of 127 acres. The current planned reclamation sequence is based on nearly immediate reclamation of any site which is no longer required by the mining or process operations.

Scheduled reclamation dates and estimated total costs to complete the reclamation of individual segments for the entire project are listed in Appendix E. Exhibit 1 details the reclamation segment areas. These items will be updated and submitted to LRCC on a yearly basis.

Exhibit 2 shows the final reclamation contours and drainage patterns.

### 3.1 MINE PITS

The mine pit slopes will be stabilized by dozing or blasting areas, benches, or slopes determined to be unstable. It is not feasible to vegetate the pit slopes and benches, since the rock surfaces are not amenable to topsoiling and seeding. Experience with pits in similar areas has shown that natural revegetation will occur on some of the stabilized areas by hardy, pioneer plant species.

The north end of the Main pit will be relatively shallow. A drainage channel will be cut through the pit slope and daylighted to allow for positive drainage of precipitation within the pit area. The area within the pit will be regraded so that water will not accumulate within the pit unless the determination is made to create a wetland area within the pit bottom (Section 5.0). A fence will be constructed around the Main pit to prevent access. Pit perimeter areas will be revegetated, the pit floor will be evaluated for revegetation depending upon its end use.

A portion of the mine waste from the Main pit will be placed into the Rainsford pit. Reclamation of the Rainsford pit will consist of contouring for drainage and revegetation.

### 3.2 WASTE ROCK DISPOSAL AREA

The retention berm in waste area "A" will be left in place. The mine waste disposal area will be graded to provide stable slopes of not greater than 3H:1V. Slopes on the surfaces of the waste disposal area will not be less than one-quarter percent to provide runoff and prevent ponding. Drainage channels will be re-established to provide for runoff and prevent erosion. Measures used to control erosion and sedimentation in drainages and channels will consist of hay bale dams or small check dams of rock or soil. The site will be revegetated as described in Section 6.0.

The sediment control ponds located in waste areas "A" and "C" will be left in-place and reclaimed for usage as replacement wetland areas, this is further described in Section 5.0.

In order to minimize total disturbance, waste area "B" is no longer scheduled for development, at this time. This will result in a property disturbance reduction of approximately 49 acres. The waste originally planned for area B will be stored in the A area and the Rainsford Pit.

### 3.3 AREA C LANDFILL

The area C landfill will be filled by the third quarter

of 1992. Upon completion, a two foot thick final cover will be left with a surface slope of at least 1% but not exceeding 4%, which will be graded to promote positive drainage. Side slopes will not exceed 3H:1V. The upper one foot of agglomerates will be compacted to a permeability of no greater than  $1 \times 10^{-6}$  cm/sec. This layer will serve as the lower one foot of the final cover. Upon completion of the low permeability layer, a protective layer of at least one foot of topsoil capable of supporting vegetation will be applied. This area will be revegetated as described in Section 6.0.

Leachate, if any, will be collected as long as its generation continues or until it meets groundwater standards.

Once the landfill is covered with the two foot thick final cover it will be graded such that surface runoff is collected and transported to NPDES outfall 003. The surface channel will be replaced with a pipe sufficiently sized to carry any additional leachate collected from the landfill.

#### 3.4 ASPHALT LEACH PAD

The asphalt leach pad is scheduled for reclamation when Phase 1 of the permanent leach pad is underway. Any agglomerates remaining on the asphalt leach pad prior to reclamation will be placed on the permanent leach pad area for additional leaching and rinsing; they will be reagglomerated if necessary. The asphalt pad will be thoroughly rinsed, then removed and either disposed of in the permanent pad when it is reclaimed; sold for reuse; or it will be removed and disposed of in a suitable landfill, (subject to waste classification). The clay liner under the asphalt will be evaluated and will be properly disposed of, if required.

As soon as the asphalt pad is removed, the area will be regraded to conform with the area drainage plan and be revegetated as described in Section 6.0.

#### 3.5 PERMANENT LEACH PAD

The final agglomerate surface will be graded to account for long term settlement and positive drainage. The leach pad areas will be graded to provide stable slopes of not greater than 3H:1V. Slopes on the surfaces of the leach pads will not be less than one-quarter percent nor greater than 4% to graded to promote positive drainage. The final surface of rinsed agglomerates will be compacted to a minimum depth of one foot except for the bench slopes. Bench slopes will be track-walked with a dozer. The compacted surface will then be covered with 6 to 12 inches of topsoil. The prepared areas will be revegetated.

Drainage channels will be re-established to provide for runoff and prevent erosion. Measures used to control erosion and sedimentation in drainages and channels will be hay bale dams or small check dams of rock or soil.

### 3.6 PROCESS SOLUTIONS

Onsite experience and review of published reports indicate that process solution volumes can be readily managed within the Barite Hill solution system without discharge. In addition, extensive "what-if" modeling of the Barite Hill water balance verifies that with proper management of the site solutions, the water balance can be maintained at an acceptable level and closed out in a reasonable amount of time utilizing evaporation. Details of the water balance are contained in the report: 1992 Water Balance Study for the Barite Hill Gold Project, WESTEC January 1992.

In the event it was determined to further expedite the closing of Barite Hill, additional means of improving evaporation, (such as heat addition), as well as a number of treatment alternatives are being actively evaluated. The treatment alternatives include chemical treatment and discharge as allowed under the NPDES permit, or land application. Test work and proposals regarding these or other methods are ongoing and will be submitted as they are completed. A summary of test work completed to date is included in Appendix A.

### 3.7 PROCESS SLUDGE AND SOLUTION PONDS

The process collection ponds will be decommissioned following closure of the permanent pad. Rinse waters meeting minimum permit requirements will be discharged as allowed by current permits or will be evaporated. When all liquid in the ponds has been removed, the remaining pond solids will be subjected to meteoric water mobility testing to determine if the material has a potential to degrade State waters if left in place. If the tests determine that the material has a negligible potential to degrade waters, the synthetic liner will be folded around the solids and buried in-place utilizing onsite clayey soils. If the test indicates a potential for degradation, the solids and possibly the liners will be treated as hazardous waste and removed to an approved facility.

The pond site or hole will be backfilled and graded to drain precipitation away from the area to further minimize infiltration potential. The areas will then be revegetated.



### 3.8 PROCESS PLANT/CRUSHER/AGGLOMERATOR

The process equipment and related facilities, (tanks, pumps, piping, etc.) will be dismantled, cleaned as required to allow shipping, and removed from the property. All office and storage facilities will be removed. The process building and concrete slabs may be dismantled or left depending upon the ultimate land disposition. Upon final reclamation of the ponds, the fencing will be removed.

The crusher facility, conveyor belts, and agglomerator will be dismantled, cleaned as required to allow shipping, and removed from the property. The trailers will be removed. The concrete pads under the agglomerator and conveyors will be pulled up and disposed of within the pond site plastic, within the reclaimed permanent heaps, or will be removed from the property depending upon final waste classification.

After cleanup is complete, the sites will be revegetated as outlined in Section 6.0.

### 3.9 ROADWAYS

Roads which are no longer required will be resloped to promote drainage, scarified, reseeded, and blocked off. Roads which are retained will be graded to insure proper drainage.

### 4.0 RINSING AND DECOMMISSIONING OF THE HEAP

Upon cessation of active leaching operations, the spent heap will be rinsed and neutralized per the permit requirements. Based on current studies, Appendix B, rinsing operations will primarily utilize hydrogen peroxide as a detoxifying agent, fresh water will also be used if the water balance allows. Testing indicates that complete rinsing of the heaps can be achieved in 120 days. Current planning calls for a minimum rinsing period of 240 days, with rinsing periods of up to 360 days. For planning purposes within the phased pads, a phase is assumed to remain open (reclamation cannot be completed) until the adjacent phase has been under rinse for a minimum of 120 days.

Rinsing of the spent heap on the permanent pad will be conducted on an intermittent basis to allow air to enter the heap and aid in degradation of cyanide species. The application rate of rinse solutions will be determined by the permeability of the heap, by experience gained during leaching operations, and from rinse-ability tests conducted during project operations. Rinseate draining from the heap will be routed to one of the lined collection ponds and either re-circulated onto the heap for additional rinsing or allowed to

evaporate. Samples of the rinsate will be collected on a regular basis. Rinsing will continue until rinseate values meet applicable limits as specified by the operating permits. At that time, rinsing will cease and the heap will be allowed to dry. Representative samples across and through the heap will be collected and subjected to meteoric water mobility tests. If the results of these tests indicate that the spent heap does not have the potential to degrade the waters of the State as a result of leaching under normal meteoric conditions, the heap will be considered neutralized. If the tests indicate that contaminants may be mobilized in sufficient quantity to degrade the waters of the State, rinsing of the heap will continue, or upon consultation with regulatory agencies, other methods will be considered to stabilize the heap, including placement of clay caps and revegetation of the heap surface for reclamation.

## 5.0 WETLAND RECLAMATION

The sediment control bench within the A-dam area, and the sediment control ponds at the A-dam, C/permanent pad area, and Main pit will be left as permanent impoundments for wildlife and water fowl use. These ponds will gradually silt in, and become established as productive grasslands. The edges along the contact with natural ground will be restored as "hardwood" wetlands.

It may be feasible to expose the floor of the Main Pit to the flood plain of the adjacent tributary thereby creating additional wetlands area. The feasibility of this option will be a function of the final pit floor elevation. At closure, this option will be re-evaluated.

## 6.0 REVEGETATION METHODOLOGY

### 6.1 SOILS STRIPPING AND STOCKPILING

The topsoil and subsoils suitable for use in reclamation will continue to be stripped from all areas prior to disturbance. The depths and areal extent of the soils suitable for stripping are field determined prior to the start of removal.

The soils are stripped using appropriate equipment and transported to identified soil stockpile areas. The stockpiled soils are stabilized, then seeded with a quick growing vegetative cover such as annual rye grass.

## 6.2 SURFACE AND SOIL PREPARATION AND AMENDMENTS

After establishing the final site grade for a reclaimed area, the surface to be reclaimed will be roughened prior to placement of topsoil to ensure a good contact. Areas compacted by heavy machinery in haulage routes, roads, or process sites will be ripped to a maximum depth of two feet to allow for root and water penetration.

The soils on site will be tested, if necessary, for amendment requirements prior to spreading of topsoil. The stockpiled soil will be spread on the graded and prepared surfaces to an average depth of eight inches, and a predetermined amount of fertilizer and lime will be applied. The surface will be disked to work the material into the soil and prepare the seedbed.

## 6.3 REVEGETATION

The prepared seedbed will be revegetated to a grassland standard using a seed mix as recommended by the Cooperative Extension Service, Clemson University or as developed on site.

The current seed and fertilizer mix being used is as follows:

		Topography	
		<u>Flat</u>	<u>Slope</u>
Seed:	Cobe Lespadisa	25 (lb/Ac)	50 (lb/Ac)
	Fescu	10	20
	Bahah	10	20
	Rye (Fall/Winter)	10	20
	Browntop Millet	10	20
	(Spring/Summer)		
Fertilizer	10/10/10	600 lb/Acre	
Lime		1,000 lb/Acre	
Mulch		1,500 lb/Acre	

This mixture will be broadcast at the specified rates. Adjustments to the mixtures, or rates will be carried out as experience is gained. Review of the mixture, topsoil, and slope characteristics will be ongoing and will be adjusted as needed.

The planting will be done as an area is prepared. As required, the revegetated areas will be top-dressed in late winter to provide for spring growth.

#### 6.4 MAINTENANCE AND MONITORING

To allow for a good stand of vegetation to become established, the revegetated areas will be protected throughout the first and second growing season. The vegetation will be monitored in the spring and all of the first growing season to determine plant germination and growth success. If necessary, remedial measures such as reseeding, additional fertilization, and weed suppression will be employed. At the end of the second growing season, the vegetation will be surveyed to ensure that there is at least a 75 percent ground cover, and no large bare spots exist.

The schedule for performing reclamation will be determined by mining and processing activities. Interim erosion control and stabilization will be done on any areas bared during construction or on features such as topsoil stockpiles, road cuts and fills, and building sites. Final reclamation and stabilization of the project site will commence as soon as the operations cease and be completed no later than the fall after the year of closure.

#### 7.0 POST CLOSURE MONITORING

The post closure monitoring of the monitor wells and landfill will be as outlined in the Groundwater Monitoring Plan submitted as a requirement of the Landfill Permit, IWP-242. A copy of this plan is included in Appendix C.

The site will be monitored upon completion of the initial site reclamation. In part, this monitoring will consist of insuring the drainages are operational and adequate, that sediment control structures are maintained and operational, and that the vegetative ground cover is returning as prescribed.

#### 8.0 OTHER RECLAMATION AND SAFETY PROVISIONS

The property and operations area will have information and warning signs posted and maintained. Access will be controlled by fencing and gates.

Upon completion of reclamation activities in a specific area, organics which have been stockpiled around the perimeter will be pulled back and scattered over the site.

Sediment control structures will be maintained as required until a satisfactory reclamation has been achieved which will prevent unnatural sediment runoff from the project site.

Drainage will be established to prevent undesirable ponding or soil erosion.

Trash or any other non-native debris will be collected and disposed of in an appropriate manner.

**APPENDIX A**  
**WATER TREATMENT STUDY UPDATE**

Preliminary Results -  
Wastewater Testing Plan, Phase II  
Nevada Goldfields, Inc.  
Barite Hill Mine

January 1992

The testing program was based on the assumption that cyanide removal is feasible as demonstrated in the Phase I testing program preformed by Nevada Goldfields and Lyntek. This proved to be the case with the sample run during this test.

The scheduled tests are to determine if discharge limits can be achieved under lab conditions using excess chemicals. Reagent optimization will be conducted at a later date after the various treatment schemes have been reviewed.

All test solution will be plant barren solution which has had the cyanide removed by alkaline chlorination in the lab. Excess chlorine will be removed by bubbling sulfur dioxide through the solution. The solution will then be divided into test aliquots to test the next steps of treatment.

Because of the low metal limits, it will likely be necessary to add a commercial flocculating aid as a final step. Tests to determine what compounds to add and optimum addition rates are generally done best by the various companies. Nalco, Drew Chemicals, Polymer Ventures, and Calgon will be contacted, and aliquots of the final solution from each test will be used by them to determine the polymer addition scheme each company recommends. If polymer addition appears not to help, other treatment schemes, such as carbon polishing or reverse osmosis may be tried.

TEST 1 - This test will use hydrogen sulfide gas to reduce and remove the chromium along with the other heavy metals. The advantage of this type of treatment is that it is only one step in addition to cyanide removal. While the reagent cost is high, the overall cost may be less because only one chemical is used. The sludge formed from this process is definitely toxic.

- |        |  |
|--------|--|
| Step 1 | Remove Cyanide   |
| Step 2 | Check pH (Make sure it is above 8 to keep from forming toxic hydrogen sulfide gas) |
| Step 3 | Bubble through H <sub>2</sub> S  |
| Step 4 | Stir   |
| Step 5 | Allow reaction time (30 min)   |
| Step 6 | Filter on .45 micron paper   |
| Step 7 | Test filtrate for metal  |

Test 1 has not yet been conducted because of the back-order on the chemicals used for gas generation. They are now in the lab and the test will be completed by the end of January.

TEST 2 - The test used a two stage process. The first to reduce the chromium to a form which can be removed by metal precipitation, and the second to precipitate all the metals. Ferrous sulfate was used as the reducing agent. The decantation step in this test is to simulate solution movement as if one pond will be used for chromium reduction and one pond for metals precipitation.

Step 1	Remove Cyanide
Step 2	Lower pH to 2.0 using $H_2SO_4$
Step 3	Add $FeSO_4$ (8:1)
Step 4	Stir for 5 minutes
Step 5	Decant into another beaker
Step 6	Raise pH to 10.5 with 50% NaOH
Step 7	Allow to react for 30 minutes
Step 8	Filter on .45 micron paper
Step 9	Send off aliquot for metals analysis

The results of this test showed the removal of the chromium (although the initial barren sample had very little to start with). However, copper, mercury, and selenium were high.

TEST 3 - This again was a two stage process. This time  $SO_2$  gas is used to reduce the chromium.  $SO_2$  is probably the cheapest reductant. The metals are precipitated out using hydrated lime rather than sodium hydroxide. The cost for the lime is less than the hydroxide but it will be harder to treat water in already full ponds due to the mixing problems it poses.

Step 1	Remove Cyanide
Step 2	Lower pH to 2.0 using $H_2SO_4$
Step 3	Add $SO_2$ gas (1:1). Bubble through a diffuser for 5 minutes
Step 4	Decant into another beaker
Step 5	Raise pH to 10.5 with lime
Step 6	Allow to react for 30 minutes
Step 7	Filter on .45 micron paper
Step 8	Split sample, send off aliquot for metals analysis.

These results were also not too promising. The final sample was split and the pH adjusted to 8.2 in one sample to compare the metal solubility at different pH. The copper was still far to high, at either pH.

TEST 4 - At the advise of the various polymer salesmen I talked to, a fourth test was added, using an organic carbamate as the only reactant. The carbamate is supposed to act like a sulfide in its reaction with the metals.

Step 1	Adjust pH to 8.2 w/ 10M NaOH
Step 2	Add three drops of carbamate
Step 3	Let stir for 30 minutes



Step 4	Add coagulant to help settle floc
Step 5	Filter on .45 micron paper
Step 6	Send off aliquot for metals analysis

This test had the best metal values but the worst copper values. It will be interesting to compare these results with those we get from the hydrogen sulfide test, because while I was told this is a sulfide precipitation, carbamates per se are not sulfur compounds.

The solids were collected in each test and air dried to a constant weight. Nothing further will be done with these solids because of the poor results of the tests.

Tests were done with chemicals suggested by Polymer Ventures, with the best results to date on copper, but still not within discharge limits. Tests with Nalco and Drew chemicals are scheduled to be run next week. It is expected that the cost of running these tests will be significantly reduced by assaying the samples for copper in-house to AA limits (approximately .1). This should help determine which addition schemes produce results worth sending off for more accurate analysis.

Results of all tests done to date are enclosed.

Received: 12/17/91

01/06/92 09:23:22

Test Description	Units	01	02	03	04
		CELL 5	BARREN	AFTER CHLORINATION	TEST 2
			BARREN	HOM AFTER	TEST 2
CADMIUM (TOTAL)	mg/l			CHLORINATION	2
CHROMIUM (TOTAL)	mg/l		0.06	0.02	<0.01
COPPER (TOTAL)	mg/l		5.63	4.76	0.44
ZINC (TOTAL)	mg/l		0.07	0.07	<0.02
MERCURY (TOTAL)	mg/l		0.0045	0.0055	0.0024
ARSENIC (TOTAL)	mg/l		0.054	0.048	0.028
LEAD (TOTAL)	mg/l		0.015	0.015	<0.005
SELENIUM (TOTAL)	mg/l		0.144	0.120	0.180
CYANIDE (TOTAL)	mg/l		87.2	<0.005	
CYANIDE (WAD)	mg/l				

Test Description	Units	05	06
		TEST 3A	TEST 3B
		pH 10.5	pH 8.2
CHROMIUM (TOTAL)	mg/l	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.71	1.12
ZINC (TOTAL)	mg/l	<0.02	<0.02
MERCURY (TOTAL)	mg/l	0.0014	0.0008
ARSENIC (TOTAL)	mg/l	0.025	<0.025 X
LEAD (TOTAL)	mg/l	<0.005	<0.005
SELENIUM (TOTAL)	mg/l	0.068	0.21

Received: 12/30/91

01/09/92 10:58:50

Test Description	Units	01	Test 4
		WW TREATMENT TEST	
TRIVALENT CHROMIUM	mg/l	<0.01	
COPPER (TOTAL)	mg/l	2.04	
ZINC (TOTAL)	mg/l	0.08	
MERCURY (TOTAL)	mg/l	<0.0002	
ARSENIC (TOTAL)	mg/l	0.024	
LEAD (TOTAL)	mg/l	<0.005	
SELENIUM (TOTAL)	mg/l	0.16	

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**Davis & Floyd, Inc.**

Laboratory Analysis Report

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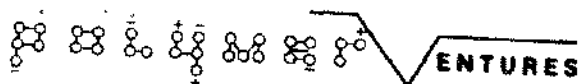
Work Order # 92-01-042

Received: 01/08/92

01/15/92 14:21:52

Test Description	Units	01 #1	02 #2	03 #3	04 #4
CHROMIUM (TOTAL)	mg/l	<0.01	<0.01	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.93	1.27	1.07	0.69
MERCURY (TOTAL)	mg/l	0.0009	0.0009	0.0009	0.0003

Test Description	Units	05 #5	06 #6
CHROMIUM (TOTAL)	mg/l	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.44	0.16
MERCURY (TOTAL)	mg/l	0.0010	0.0005

**Jon Fabri**

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October 25, 1991

Mr. Rick Dye  
Nevada Goldfields, Inc.  
Barite Hill Project  
P.O. Box 1510  
McCormick, SC 29835

Dear Mr. Dye:

Following is a summary of the water treatment testwork completed to date at the Barite Hill laboratory along with recommendations for Phase 2 of the study. Phase 1 of the program has been completed, however, the results have been less than encouraging.

Tests 13 through 21 were conducted to evaluate several common methods of water treatment to eliminate cyanide and heavy metals from solution. The water that was treated was plant barren. The barren solution is currently showing an excess in inventory at Barite Hill and would be the target for treatment and release. Table 1, is a summary of all of the results from the tests.

#### CHLORINATION TESTS

Two stage chlorination tests were conducted utilizing both sodium and calcium hypochlorite. The tests were run generally following the procedure outlined in the communication to the Barite Hill site from Lyntek, Inc dated September 16, 1991. The stoichiometric ratio of (OCI) to CN was approximately 14:1 for the first stage and 7:1 for the second stage, the recommended level of additions.

Tests 16 and 18-4 were conducted on 9-24 and test 18 was performed on 9-25. Presumably the same barren sample and procedures were followed for all tests.

The results were very erratic. Mercury results indicate analytical error or contaminated samples could have occurred. The results for the tests show an order of magnitude more mercury in the effluents than in the barren feed.

Cadmium in the barren feed and effluent samples of every test conducted was below the detection limit of 0.001 ppm. The NPDES requirement for cadmium is 0.01 ppm. Cadmium analysis can probably be eliminated from the analytical scheme except for analysis of the feed barren for the next set of tests and perhaps one check on one effluent.

A7

Barium in the barren feed was 1.23 ppm which is very close to the NPDES limit of 1.0 ppm. Removal of barium to less than 1.0 ppm was accomplished in every test except for Test 20, which has shown very inconsistent results in several areas. Barium analysis should also be eliminated from the analytical scheme expect for barren and two effluents as listed in the list of second phase tests, following.

Selected results of the tests are shown for comparison in Table 2.

TABLE 2 COMPARISON OF RESULTS OF CHLORINATION TESTS

TEST	AS	CR	CU	PB	SE	ZN
16 CA	0.029	0.071	0.040	<0.011	<0.016	<0.001
18-4 CA	0.129	0.193	0.110	0.956	1.33	0.038
21 NA	<0.009	0.040	0.006	<0.011	0.130	<0.001
BARRN	0.047	0.124	13.7	0.051	0.197	0.398
NPDES	<0.005	0.011	0.001	0.050	<0.005	0.059

No data is available on free cyanide or WAD cyanide results for the chlorination tests. Total cyanide was run by the outside lab for the effluent from test 16 only. The result was less than 0.001 ppm. The NPDES limit for total cyanide is 0.01 ppm.

Test 18-4 has results that are so inconsistent, with several metals at higher levels in the effluent than in the feed, that it should probably be ignored in the evaluation process.

Arsenic removal was facilitated by two stage chlorination. Although the detection limit was above the NPDES requirement, a significant advantage was observed with the second stage addition of hypochlorite.

Copper removal was also significantly enhanced by the second stage of chlorination, although the NPDES level of 0.001 ppm was not quite reached.

Lead and zinc results are very erratic when Test 18-4 is considered, but very consistant if Test 18-4 is thrown out. NPDES limits for both metals are easily met by chlorination.

Since no comparative data is available, and the results on the metal removal are so inconclusive, repeating of the double chlorination utilizing both calcium and sodium cation is indicated.

## HYDROGEN PEROXIDE TESTS

Single hydrogen peroxide tests were conducted utilizing copper added as a catalyst. Tests 15 and 20 were single stage tests utilized additions of about 7:1 H<sub>2</sub>O<sub>2</sub>:CN for CN concentrations above 2 ppm, which both barren feed solutions were. Test 19-4 was a confirming test for the VM-40 reagent which will be discussed later. Test 14 utilized a single stage of peroxide addition at 7:1 followed by 0.167 grams per liter of Ca(OH)<sub>2</sub>.

The results for total cyanide (0.668-0.741ppm), Copper (1.97-4.46ppm), and Selenium (0.223-0.246ppm) were relatively constant for the four tests. Results, however varied significantly for other metals as shown in Table 2.

Again, barium and cadmium levels are acceptable for all tests. Zinc reduction is also acceptable for all tests.

Selected results of the peroxide tests are shown in Table 3.

TABLE 3 COMPARISON OF RESULTS OF HYDROGEN PEROXIDE TESTS

TEST	SEQUENCE	AS	CR	PB	HG	2N
14	H <sub>2</sub> O <sub>2</sub> /LIME	<0.009	0.124	<0.011	<0.001	0.045
15	H <sub>2</sub> O <sub>2</sub>	0.024	0.102	<0.011	0.004	0.008
19-4	H <sub>2</sub> O <sub>2</sub>	0.056	0.124	<0.011	<0.001	<0.001
20	H <sub>2</sub> O <sub>2</sub>	0.050	1.38	0.196	0.007	<0.001
	BARREN	0.047	0.124	0.051	<0.001	0.398
	NPDES	<0.005	0.011	0.050	0.0002	0.059

The results for copper are not unexpected due to the 5 ppm addition to act as catalyst. A second stage of treatment, probably chlorination, would probably reduce the copper levels to within an order of magnitude as indicated in test 21, double chlorination.

The total cyanide achieved with peroxide is not an acceptable level according to the NPDES limit. In the next round of tests, the free and WAD cyanide analysis should be conducted on every effluent in addition to the total. These analyses should shed some light on the trends to be expected relative to various species of cyanide neutralized by the different oxidizers employed.

Arsenic has been reduced to the detection level in one peroxide test only; that one employing lime addition. This might indicate that if peroxide is utilized, that the pH could be kept at a relatively high level, 12.5 or more with lime for at least one stage.

Lead and zinc levels below NPDES to be achievable with single stage peroxide reaction with the notable exception of Test 20 for lead, which could be an inconsistent analytical result only. It should be noted that other metals levels results from Test 20, chromium, and mercury in particular, are an order of magnitude higher than other tests in general, indicating a possibility that the test was conducted improperly or that the samples were contaminated.

Practically no chromium removal was achieved by peroxide neutralization, with Test 20, again, showing more chromium in the effluent than in the feed barren.

Mercury removal was relatively erratic with more mercury in the effluent than in the feed for Tests 15 and 20. This may be analytical error due to the result of being very close to the detection limit.

#### FERROUS SULFATE/HYDROGEN PEROXIDE TEST

Test 13 was conducted utilizing ferrous sulfate first stage addition followed by hydrogen peroxide reaction. The test was run utilizing 4:1  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}:\text{CN}$  free for 6 hours at a starting pH of 11.26. The final pH was 8.9. The solution was filtered on 0.45 micron paper, the free cyanide was analyzed and 6:1  $\text{H}_2\text{O}_2:\text{CN}$  was added and reacted for an unknown time.

The resulting free cyanide run at Barite Hill was 5.4 ppm. The total was run by the outside lab with a result of 93.6 ppm. The NPDES level of 0.01ppm total was not approached by this sequence.

Barium, cadmium, lead, and zinc reached levels below the NPDES limits. Again, mercury in the feed and effluent were the same at <0.001 ppm.

This sequence produced the only chromium result, <0.003, of all the tests that was below the NPDES limit of 0.011 ppm.

Selenium and arsenic effluent levels were higher than the barren feed.

Copper reduction was to a level of 8.82 ppm vs. the NPDES limit of 0.001.

Evaluation of the results, particularly relating to cyanide and copper removal indicate that this scheme will probably not work too well, and can probably be eliminated from the test program.



## POLYMER VENTURES METAL REMOVAL TESTS

Results of all of the tests conducted to evaluate the capabilities of these reagents were unsatisfactory. It should be noted, however, that the results of the control tests, numbers 18-4 and 19-4 produced unsatisfactory results, therefore the problems initially seen with the polymer reagents were not necessarily due to those reagents.

If this reagent is used in the second phase of the testwork, these reagents should be tested at the maximum level of 400 ppm in conjunction with chlorination and hydrogen peroxide. Considering the high cost of analysis, and the limited initial result, one test only of each are indicated. An economic analysis shows that this reagent will be very costly and currently not showing significant results.

## SECOND STAGE TREATMENT TEST PROGRAM

Due to the limited useful results obtained from the initial series of tests, it is recommended that the entire test program be repeated as initially run. The list of tests to be completed follows:

### Chlorination Tests

#### Test 1. Two Stage Chlorination - Calcium Hypochlorite

1. Adjust the pH to 10.5
2. Add Calcium Hypochlorite at a stoichiometric ratio of 3 or 4:1 OCl:free CN.
3. React for 30 minutes
4. Allow to settle and filter on 0.45 micron paper
5. Measure free CN
6. Adjust pH to 8.0
7. Add Calcium Hypochlorite at a ratio of 6:1 OCl: free CN left in effluent from first stage
8. React for one hour
9. Allow to settle and filter on 0.45 micron paper  
Monitor free cn

#### Test 2. Two stage Chlorination - Sodium Hypochlorite

1. Repeat Test 1.

#### Test 3. Two stage Chlorination - VM 40 Polymer Reagent

1. Repeat Test 1 - Calcium Hypochlorite
2. Add 400 ppm of VM-40 Polymer reagent
3. React for 15 minutes
4. Flocculate (optional), allow to settle and filter on 0.45 micron filter

#### Test 4. Single stage Chlorination - Sulfidization

1. Repeat steps 1 through 6 of Test 1
2. Add 100 ppm Potassium Meta-Bisulfite or Hydrogen sulfide
3. React one hour
4. Allow to settle and filter on 0.45 micron paper

## Hydrogen Peroxide Tests

### Test 5. Single stage Hydrogen Peroxide

1. Adjust pH to 11.5
2. Add 6 ppm Cu as  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  solution
3. Add  $\text{H}_2\text{O}_2$  at a stoichiometric ratio of 4:1  $\text{H}_2\text{O}_2$ :CN
4. React for 3 hours
5. Allow to settle and filter on 0.45 micron paper  
Monitor free cn

### Test 6. Two stage Hydrogen Peroxide

1. Follow procedure for Test 5
2. Measure free cyanide concentration
3. Adjust pH to 10.5 to 11.0
4. Add 6 ppm Cu as  $\text{CuSO}_4 \cdot \text{H}_2\text{O}$  solution
5. Add  $\text{H}_2\text{O}_2$  at a stoichiometric ratio of 4:1  $\text{H}_2\text{O}_2$ :CN if the free cyanide level is greater than 2 ppm, or 6:1 if the level is less than 2 ppm.
6. React for 3 hours
7. Allow to settle and filter on 0.45 micron paper

### Test 7. Two stage Hydrogen Peroxide - VM 40 Polymer

1. Follow procedure for Test 6
2. Add 400 ppm of VM-40 Polymer Reagent
3. React for 15 minutes
4. Flocculate(optional), allow to settle and filter on 0.45 micron paper

### Test 8. Two stage Hydrogen Peroxide - Sulfidization

1. Follow procedure for Test 6
2. Add 100 ppm of Potassium Meta-Bisulfite or Hydrogen Sulfide
3. React for one hour
4. Allow to settle and filter on 0.45 micron paper

## General Condition and Considerations for all Tests

Cyanide analyses for free, WAD, and total need to be performed for each final effluent. Free cyanide analysis needs to be performed at Barite Hill on each barren feed and intermediate product produced during the testwork.

Closer control of each test needs to be exercised during the testing program. Extensive logging of test conditions and observations is mandatory, with daily reporting of each day's activities to management and also to Lyntek, Inc. for review and input.

All solids produced during the testwork will be retained for compositing and TCLP analysis to determine the waste characteristics relating to eventual disposal of the sludge generated during the water treatment process, whether it be interim or at the end of the project.

Outside laboratories should be retained that can analyze to the detection limits specified in the NPDES Permit, particularly in regard to Total Cyanide (0.01 ppm), Arsenic (<0.005 ppm), Mercury (0.0002 ppm), and Selenium (<0.005 ppm).

Barium and cadmium need not be analyzed for in each sample except as mentioned above, whereby the barren and one effluent sample from two different tests will be analyzed. The effluent from the two stage chlorination test (Test 1), and the two stage hydrogen peroxide test (Test 6) should be analyzed for these two metals.

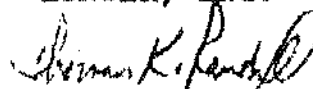
Measurement of the flow conditions in Howe Creek should be continued to allow application for higher dilution rates to be made at the time the new NPDES permit to discharge treated process solutions is made to the state.

This program of testwork should be carried out very carefully, remembering that data generated will be used to help facilitate the permit application process. Certain levels of metals may be unattainable by available technology. Well documented test procedures and results will be necessary to prove that available technology has been tested in a competent manner.

Should you have questions or input concerning this treatment program and philosophy, please feel free to contact myself directly.

Sincerely,

LYNTEK, INC.



for Nicholas S. Lynn

NSL/ris

NEVADA GOLDFIELDS, INC.  
WATER TREATMENT STUDY

BARITE HILL PROJECT

TABLE 1 SUMMARY OF PHASE 1 WATER TREATMENT PROGRAM

*****													
	CYANIDE												
TEST NO.-DESCRIPTION	FREE	WAD	TOTAL	SULFATE	ARSEC	BARIUM	CDMIUM	CRMIMUM	COPPER	LEAD	MRCURY	SINIUM	ZINC
=====													
WATER TREATMENT - PHASE 1													
13 - FESO4.7H2O/H2O2	5.4(1)		93.6		0.48	0.728	<0.001	<0.003	8.82	0.020	<0.001	0.213	0.010
14 - 2 STAGE PEROXIDE			0.741		<0.09	0.873	<0.001	0.124	2.35	<0.011	<0.001	0.231	0.045
15 - H2O2/Ca(OH)2			0.684		0.04	0.824	<0.001	0.102	1.97	<0.011	0.004	0.225	0.008
16 - SINGLE STAGE CHLORINATION:			<0.020		0.09	0.442	<0.001	0.071	0.040	<0.011	0.013	<0.016	<0.001
17 - BARREN SAMPLE		65.8	238	22.2	0.47	1.23	<0.001	0.124	13.7	0.051	<0.001	0.197	0.398
18-1 - 2 STAGE CHLOR/VM-40					0.19	0.554	<0.001	0.193	0.101	1.04	0.006	1.40	<0.001
18-2 - 2 STAGE CHLOR/VM-40					0.29	0.554	<0.001	0.253	0.190	2.03	<0.001	1.37	0.138
18-3 - 2 STAGE CHLOR/VM-40					0.39	0.524	<0.001	0.263	0.070	1.48	0.003	1.45	<0.001
18-4 - 2 STAGE CHLOR-CONTROL					0.29	0.554	<0.001	0.193	0.110	0.956	0.008	1.33	0.038
19-1 - H2O2/CU/VM-40					0.80	0.925	<0.001	0.135	0.024	0.298	<0.001	0.265	0.001
19-2 - H2O2/CU/VM-40					0.41	0.909	<0.001	0.132	0.014	0.452	<0.001	0.286	<0.001
19-3 - H2O2/CU/VM-40					0.87	0.950	<0.001	0.104	0.682	0.044	<0.001	0.252	<0.001
19-4 - H2O2/CU/CONTROL					0.56	0.930	<0.001	0.124	2.36	<0.011	<0.001	0.246	<0.001
20 - H2O2/CU			0.568		0.50	1.15	<0.001	1.38	4.46	0.196	0.007	0.223	<0.001
21 - 2 STAGE CHLORINATION			<0.020		<0.09	0.235	<0.001	0.040	0.006	<0.011	0.011	0.130	<0.001
NPDES DISCHARGE LIMITS			0.01	( )	<0.05	0	0.01	0.011	0.001	0.05	0.0002	<0.005	0.059
*****													

**APPENDIX B**  
**SPENT ORE RINSING STUDY**

**HEAP DETOXIFICATION EVALUATION**

NEVADA GOLDFIELDS, INC.  
BARITE HILL PROJECT  
McCORMICK, SOUTH CAROLINA

Scott A. Wilkinson  
Process Superintendent  
January 1992

## SUMMARY

The data presented in this report clearly shows that the leached agglomerates at the Barite Hill Project can be sufficiently rinsed, to State effluent discharge standards, in approximately 120 days.

The report outlines a test series starting from bench testing into column testing followed by full scale heap testing. The results and conclusions from each test have readily allowed for an acceptably accurate prediction of what would be the outcome of the following tests. Continued full scale rinsing using hydrogen peroxide will continue to expand the base data gained so far allowing for ongoing adjustment within the process, if required.

Several options are available for providing rinse solution. Fresh or well water would be the most desirable if solution inventory permitted, in the event process solution must be detoxified and used for rinse solution, hydrogen peroxide treatment will be the next choice as an effective and efficient alternative. Chlorination, while also an effective treatment of process solutions was not tested beyond the column testing phase.

## INTRODUCTION

In a load/unload (reusable leach pad) type of heap leach gold operation the amount of time ore is on the heaps is of critical economic importance. Process cycle time is consumed in leaching the gold from the ore and rinsing the heaps to reduce cyanide and heavy metal concentrations within the heaps thus allowing disposal of the residue to the environment. The turnover of the heaps must flow in a cyclic manner in order to leach the gold bearing ores in sufficient quantity to make the project economically feasible. An extended heap detoxification cycle will have a substantial impact upon the economics of a given project as was the case experienced at the Barite Hill Project.

## DISCUSSION

Initial project design called for ferrous sulfate to be used as the neutralizing reagent to reduce the cyanide levels contained in the rinse solution and cyanide levels contained within the heaps. Effluent from the heaps would return to the pregnant solution pond where the ferrous cyanide complex would ultimately settle to the bottom of the pond. Barren solution, or fresh water if the water balance permitted, from the plant was to be treated with a ferrous sulfate solution and returned to the heaps.

The treatment circuit contained within the process plant proved to be of little practical use for ferrous sulfate treatment of the barren solution. Mixing of the ferrous sulfate within the mixing



tank could not in all practicality be accomplished quickly enough to adequately treat the required flow rates of barren solution. The next course of action was to batch treat the barren solution in one of the process ponds.

Batch treatment of the barren solution in the ponds proved difficult and time consuming. Total cyanide levels consistently were measured above 2 mg/L, whereas the required total cyanide levels of the rinse solution is less than 0.2 mg/L. Acidification, after ferrous sulfate complexation, of the treated rinse solution also proved to be inadequate in the reduction of the total cyanide levels to less than 0.2 mg/L. The conclusion was drawn that ferrous sulfate treatment for the barren solution to the required limit of total cyanide at less than 0.2 mg/L was not feasible, given the operational difficulties within an acceptable time frame, for this project and an alternative method of treatment was required.

Therefore investigation of a system which required less intensive labor and monitoring was begun. Laboratory bench tests were conducted utilizing various reagents to detoxify cyanide contained in the process barren solution. Both hydrogen peroxide and chlorination treatments proved capable of quickly treating the process barren solution to total cyanide levels which were non-detectable. Appendix A shows results obtained from NGI's and FMC's bench tests. Column tests were initiated to simulate actual operating conditions which might be expected.

## PROCEDURE

### Column Tests

Six columns, 6 inch diameter by 5 ft. length, were constructed. The columns were built of PVC schedule 40 pipe. The bottoms were capped with PVC reducers and had a 1/2 inch valve outlet attached. Solids were kept from draining through the valve assembly by a 1/2 inch expanded metal screen placed in the bottom of the column. The screen was covered with approximately 1 inch of glass wool. Influent solutions were delivered to the tops of the columns by small peristaltic metering pumps. Effluent drained from the column into collection buckets. Due to space availability and limited personnel, the column tests were run in batches of three.

Residue from cell #3 was used for the column tests. Cell #3 had been under leach for approximately 30 days. It was assumed this material would be representative of leached residues in the future. Each column was filled with residue material. The wet weight of the residue was determined by weighing the residue as it was put into the columns. The amount of moisture for the residue was determined by taking a sample representative of the material, weighing the sample, drying the sample and then weighing the

sample. The difference between the two weights was moisture contained and the percent moisture was determined for the residue.

Dry residue weights were determined for each column by subtracting the percent of contained moisture from the wet weight of the residue. Pore volume of the residue was determined on four of the six columns. On the first set of column tests, pore volume was determined on one column only. It was assumed the other two columns would have the same pore volume. On the second set of column tests pore volumes were determined for each column.

Influent solution for all six columns was treated daily to try and simulate expected operating conditions, which were assumed to be basically a batch treatment in the process pond. The barren solution was treated with ratios of reagent to cyanide based upon bench test data. Table 1 shows the treatment selected for each individual column.

TABLE 1

Column No.	Reagent	Reagent/Cyanide
One	Calcium Hypochlorite	3:1 (Cl:CN)
Two	Hydrogen Peroxide w/Cu catalyst	4:1
Three	Sulfuric Acid	21.6:1
Four	Hydrogen Peroxide w/Cu catalyst	4.5:1
Five	Ferrous Sulfate	4:1
Six	Well Water	N/A

In column tests #1 through #5, the reagents were used to treat the total cyanide level in the barren process solution to a concentration of less than 0.2 mg/L. Column six influent solution was well water which did not require a detoxifying reagent. In all six column tests, the treated solution was passed through the columns at a controlled rate until the effluent total cyanide concentration reached 0.2 mg/L or the test indicated a particular treatment method was unsatisfactory. Tables showing daily column result and graphical depictions of the results are contained in Appendix B of this report.

Once the desired total cyanide levels were attained, the columns were allowed to drain completely. The rinsed residue was removed from the columns. Solid samples were taken of the residue, one sample to approximate the upper horizon of the column with the other sample representing the lower horizon of the column. The solid samples were sent to an independent laboratory for analysis. Extractions were performed on the solid sample following the EPA TCLP protocol. The extracts were analyzed for cyanide (total & WAD), total residual chlorine, sulfide and total metals (As, Cu, Hg, Pb, Cd, Se, Ba, Cr). The certificate of analysis received from the laboratories are contained in Appendix C of this report. Table 2 shows a comparison of the individual columns and the analysis of

each parameter for the columns.

TABLE 2

COLUMN	1 Upper	2 Upper	3 Upper	4 Upper	5 Upper	6 Upper
CN total	0.334	0.479	0.379	1.300	8.500	1.100
CN WAD	0.066	0.053	0.239	2.230	3.320	<1.000
TCLP metals						
As	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	1.13	1.25	0.17	0.985	0.691	2.54
Cd	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	0.04	<0.02	0.03	<0.2	<0.02	<0.02
Pb	<0.05	<0.05	<0.05	<0.05	<0.05	0.355
Hg	0.0024	<0.0002	0.0012	<0.001	<0.001	<0.001
Se	<0.05	<0.05	<0.05	0.107	0.104	0.103
Ag	0.015	<0.01	<0.01	<0.01	<0.01	<0.01
S	0.1	0.1	<0.05			
LOWER						
COLUMN	1 Lower	2 Lower	3 Lower	4 Lower	5 Lower	6 Lower
CN total	0.290	0.233	0.774	<1.000	8.700	1.800
CN WAD	0.048	0.034	0.440	<1.000	5.590	<1.000
TCLP metals						
As	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ba	0.97	1.09	0.29	1.19	0.671	1.38
Cd	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	0.02	0.02	<0.02	<0.2	<0.2	<0.2
Pb	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hg	0.0007	<0.0002	0.0016	<0.001	<0.001	<0.001
Se	0.1	<0.05	<0.05	0.128	0.107	0.110
Ag	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
S	0.1	0.08	0.1			

\* NOTE: Columns 1-3 CN results reported as TCLP values, columns 4-6 CN results reported as soil analysis values.

Upon reviewing the data obtained from the column tests, some observations can be made.

1. Columns 1, 2, 4, and 6 showed the most promising results.
2. Both the chlorination treatment (test 1) and the hydrogen

peroxide treatment (tests 2 & 4) compared favorably with the well water test (test 6).

3. Both the upper and lower horizons in the column tests showed extremely good correlation in all parameters tested. This demonstrates the ability to rinse the ore thoroughly.
4. The levels of detoxification were attained in an acceptable amount of time.

From this testing, three different options were considered available for detoxifying the heaps.

1. Using well water as solution inventories permit.
2. Detoxifying process barren solution with hydrogen peroxide and using the resultant solution for rinsing.
3. Detoxifying process barren solution with chlorine and using the resultant solution for rinsing.

The decision was made to utilize hydrogen peroxide as a detoxifying reagent for a full scale heap test. It was determined hydrogen peroxide treatment would be more cost effective in addition, any by-products produced from the hydrogen peroxide treatment would be more desirable than by-products produced from chlorination treatment. Well water was not used for the full scale heap test due to the undesirable impacts any additional solution would have had on the overall solution inventory at the time.

#### PREDICTIONS

Utilizing the data from the column test, predictions were made as to what might be expected from a full scale heap test.

Pore volumes for the six columns ranged from 11%-13.6%. Assuming an average pore volume of 12.3% per heap equates to 1 pore equaling 649,440 gallons of solution for a heap containing 20,000 tonnes of residue. Assuming a flow rate of 150 gpm through the heap, it will take 3 days to pass 1 pore volume of solution through the heap. The column tests where hydrogen peroxide was used as the detoxifying reagent required an average of 12.75 pore volumes to pass through the column before the cyanide level in the effluent was reduced to less than 0.2 mg/L. Assuming that the test heap contained 20,000 tonnes of residue and required 12.75 pore volumes to pass through the heap, a rinse cycle of approximately 38.3 days would be required. Applying a scale-up factor of 2X from the column data, would suggest a rinse cycle of 76.6 days.

Utilizing the data obtained from the same columns as above, but

comparing solution weight passed through the column to the dry weight of the material suggests a longer rinse cycle will be required. On the average for every kilogram of residue (dry) contained within the column 1.8 kilograms of rinse solution was passed through the column to obtain a cyanide level in the effluent of less than 0.2 mg/L. Assuming a test heap of 20,000 tonnes, 9.5 million gallons of rinse will pass through the heap to achieve the desired cyanide levels in the effluent. Based upon a flow rate of 150 gpm, the rinse cycle would be 44 days. Using a 2X scale-up factor applied to the column data, suggests a rinse cycle of 88 days.

Based upon experience, it can be assumed that under ideal conditions, the rinse cycle will actually fall somewhere between the two indicted cycle times of 76.6 to 88 days to reduce cyanide levels to less than 0.2 mg/L.

#### FULL SCALE HEAP TEST

A full scale heap test was initiated at the project. As previously stated, hydrogen peroxide was chosen as the detoxifying reagent. It was determined the Ferrous Sulfate treatment circuit within the ADR plant could be readily modified to make it suitable for hydrogen peroxide treatment of the process solution.

Cell six was chosen for the heap test. The estimated dry tonnage for the heap on cell six was 15,500 tonnes. Barren solution from the process plant was initially treated with the hydrogen peroxide to obtain a sufficient volume of rinse solution for the closed loop circuit. Application of barren solution to cell six was stopped approximately 24 hours before beginning the rinse test. The hydrogen peroxide, as predicted, quickly reduced the effluent cyanide levels to 0.2 mg/L. Various operational problems typical to start up of a new system such as pump-application compatibility, scaling of pipes, operator training, etc, were encountered during the test, thereby reducing the planned overall rinse rate. The problems were corrected as they arose.

Operating constraints at the project required the controlled test be concluded after 42 days of rinsing (rinsing did continue after this time but there was contamination of the final effluent from adjacent leaching). The heap was sampled and the solid samples sent to an independent laboratory for analysis. Sufficient data was collected from the heap test to make comparisons to the column tests and by extrapolating the available data over time, draw some firm conclusions as to how much time will be required for a typical rinse cycle.

During the heap test 3,118,102 gallons of process solution was passed through the heap. This equates to a process solution to residue ratio of 0.76:1.00 and an average flow rate of 52 gpm

through the heap over the 42 day test. This flow rate was significantly less than the desired steady rate of 150 gpm. The reduced flow rate through the heap had a significant impact on the amount of time required to detoxify the heap. With a higher flow rate through the heap, the cyanide levels would have been reduced to much lower level at the end of the 42 days of rinsing. The cyanide levels measured in the effluent in the last few days of the rinse test ranged between 20-35 mg/L. An end point of 27.5 mg/L cyanide was used to compare the heap test to the column test. Appendix D lists the daily flow rates, effluent pH and cyanide levels of cell 6 heap test.

The column test 2, peroxide test, had an approximate process solution to residue ratio of 0.52:1.00; which was lower than the heap test, when effluent cyanide levels were measured in the 27 mg/L range. Column test 4, also hydrogen peroxide, had an approximate process solution to residue ratio of 0.66:1.00, again lower than the heap test, when effluent cyanide levels were measured in the 27 mg/L range. Compared with column 2, rinsing of the heap was taking 43.4% longer than the column data suggested. Compared with column test 4, rinsing of the heap was taking 15.2% longer than the column data would suggest. Therefore, using either column test a factor of 2X applied to the column test data is justified when the actual results obtained from the heap test are compared to the column test data.

Upon completion of the heap test, the residue was sampled at varying depths within the heap. The samples were sent to an independent laboratory and subjected to 2 different tests; Soil analysis, and TCLP Analysis, both following EPA protocol. The certificate of analysis received from the laboratory are contained in Appendix E of this report. Soil analysis indicates what constituents are actually contained within the solids while TCLP analysis indicates what constituents would be readily mobilized in the event of rain water percolating through the solids.

Evaluation of TCLP analytical results from the residue samples show that after 42 days of rinse, mobile metals had been significantly reduced and total cyanide concentration averaged 0.99 mg/L. Evaluation of total solids analytical results showed significantly higher metal concentrations than the TCLP analysis, and an average total cyanide concentration of 49.8 mg/L. Table 3 shows a comparison of the TCLP and total ore analytical results.

TABLE 3

## Soil Analysis

Parameters	Interval 0'-5'	Interval 5'-10'	Interval 10'-15'
CN total	32.9	64.2	52.3
CN WAD	<6.1	<6.1	8.1
Cd	7.9	4.1	4.2
Cu	344.0	188.0	141.0
Zn	24.0	22.0	25.0
Ag	1.4	<0.61	1.06
Hg	<0.12	<0.12	<0.12
As	527.0	249.0	259.0
Pb	377.0	285.0	392.0

## TCLP Analysis

Parameters	Interval 0'-5'	Interval 5'-10'	Interval 10'-15'
CN Total	0.163	1.1428	1.132
CN WAD	0.020	0.152	0.214
Ba	0.92	0.87	0.98
Cd	<0.005	<0.005	<0.005
Cr 3	<0.01	<0.01	<0.01
Cr 6	<0.01	<0.01	<0.01
Cu	0.14	<0.01	<0.01
Zn	0.10	0.03	0.03
Ag	N/A	N/A	N/A
Hg	0.0003	0.0008	0.0016
As	<0.005	0.006	<0.005
Pb	<0.05	<0.05	<0.05
Se	<0.005	<0.005	<0.005

Although the heap test was concluded before the cyanide levels in the effluent were reduced to 0.2 mg/L; extrapolation of the data obtained during the 42 days of rinsing indicates the cyanide level of the effluent would be 0.2 mg/L in 180 days at a flow rate of 52 gpm. Cyanide levels in the heap effluent were reduced an average of 39% for every ten days of rinsing. The reduced application rate of the rinse solution during the heap tests accounts for the longer rinse time experienced during the heap test than was otherwise predicted. With a proper application rate (150 gpm) of rinse solution to the heap, the scale-up factor of 2X applied to the column tests is still valid, which gives a rinse cycle time of approximately 90 days. Assuming actual operating conditions will

be less than ideal, a rinse cycle time of approximately 120 days is anticipated. A rinse cycle time of 120 days falls between the controlled laboratory column tests and the full scale heap test in which start-up problems were encountered.

Upon review of the data available from the column test work, the heap test and the results from the solid samples taken from the heap, the rinsability of the heaps is not questionable. All data demonstrates the heaps can be rinsed adequately given a sufficient rinse cycle.



APPENDIX A  
NGI AND FMC  
CYANIDE DETOXIFICATION BENCH TEST RESULTS

Cyanide mg/L (Free)  
Chlorine Detoxification

Time (Hr)	7:1 <u>Cl:CN</u>	4:1 <u>Cl:CN</u>	3:1 <u>Cl:CN</u>	2:1 <u>Cl:CN</u>
6	ND	ND	ND	ND
20				
24				

Cyanide mg/L (Free)  
Peroxide Detoxification

Time (Hr)	4:1 <u>H<sub>2</sub>O<sub>2</sub>:CN</u>
6	ND
20	
24	

Cyanide mg/L (Free)  
Sulfuric Acid Detoxification

Time (Hr)	7:1 <u>H<sub>2</sub>SO<sub>4</sub>:CN</u>	21.6:1 <u>H<sub>2</sub>SO<sub>4</sub>:CN</u>
6	.65	ND
20		
24		

Cyanide mg/L (Total)  
Chlorine Detoxification

Time (Hr)	7:1 <u>Cl:CN</u>	4:1 <u>Cl:CN</u>	3:1 <u>Cl:CN</u>	2:1 <u>Cl:CN</u>
6	NA		NA	0.59
20	NA	ND		
24				

Cyanide mg/L (Total)  
Peroxide Detoxification

Time (Hr)	Test #2 4:1 <u>H<sub>2</sub>O<sub>2</sub>:CN</u>	Test #1 4:1 <u>H<sub>2</sub>O<sub>2</sub>:CN</u>
6	ND	.63
20		
24		

detection limits = 0.1 mg/L

ND = non-detectable by ion selective determination.

APPENDIX B  
LABORATORY COLUMN TESTS RESULTS AND GRAPHS

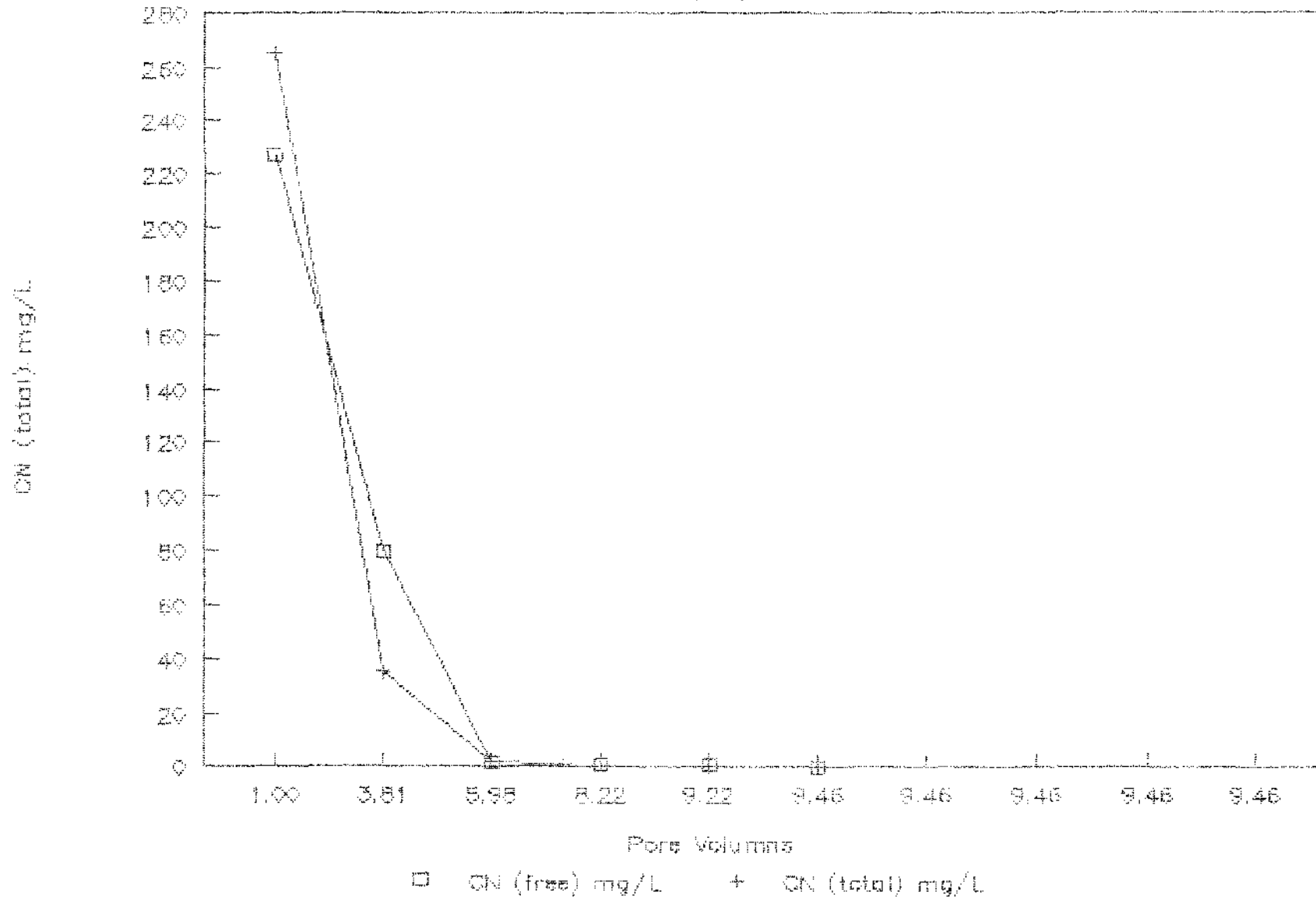
Nevada Goldfield Inc.  
Column Test Results (Detoxification)

Date: 4 Sept 91  
Column #: 1  
Wet wt. (Kg): 39.07  
Moisture %: 19.6  
Dry wt. (Kg): 31.41  
P.V. (Kg): 4.3

Days #	Applied Kg	Collected Kg	Collected Cum. Kg	P.V. #	P.V. Cum.	pH	CN (free) mg/L	CN (total) mg/L
1	9.7	4.3	4.3	1.00	1.00	10.8	227	265
2	14.61	12.07	16.37	2.81	3.81	10.8	80	35
3	9.74	9.34	25.71	2.17	5.98	10.8	2	1.85
4	10.17	9.65	35.36	2.24	8.22	10.5	0.71	0.51
5	3.69	4.3	39.66	1.00	9.22	10.4	0.54	<0.05
6	0	1	40.66	0.23	9.46	7.3	0.24	<0.05
7			40.66	0.00	9.46			
8			40.66	0.00	9.46			
9			40.66	0.00	9.46			
10			40.66	0.00	9.46			
Totals:	41.91	40.66		9.46				

# Column 1

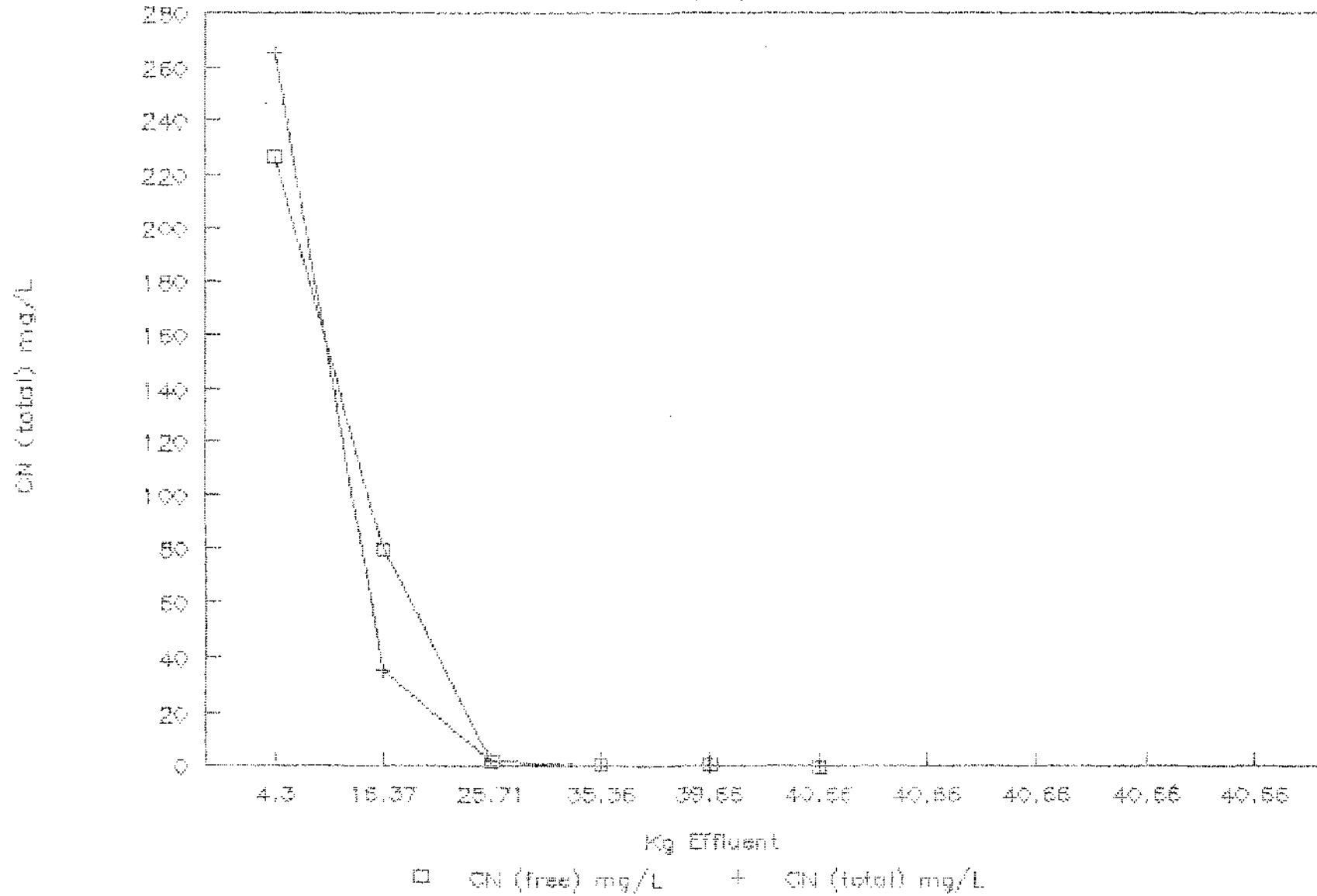
$\text{Ca}(\text{ClO})_2$



B14

# Column 1

$\text{Ca}(\text{ClO})_2$



BIS

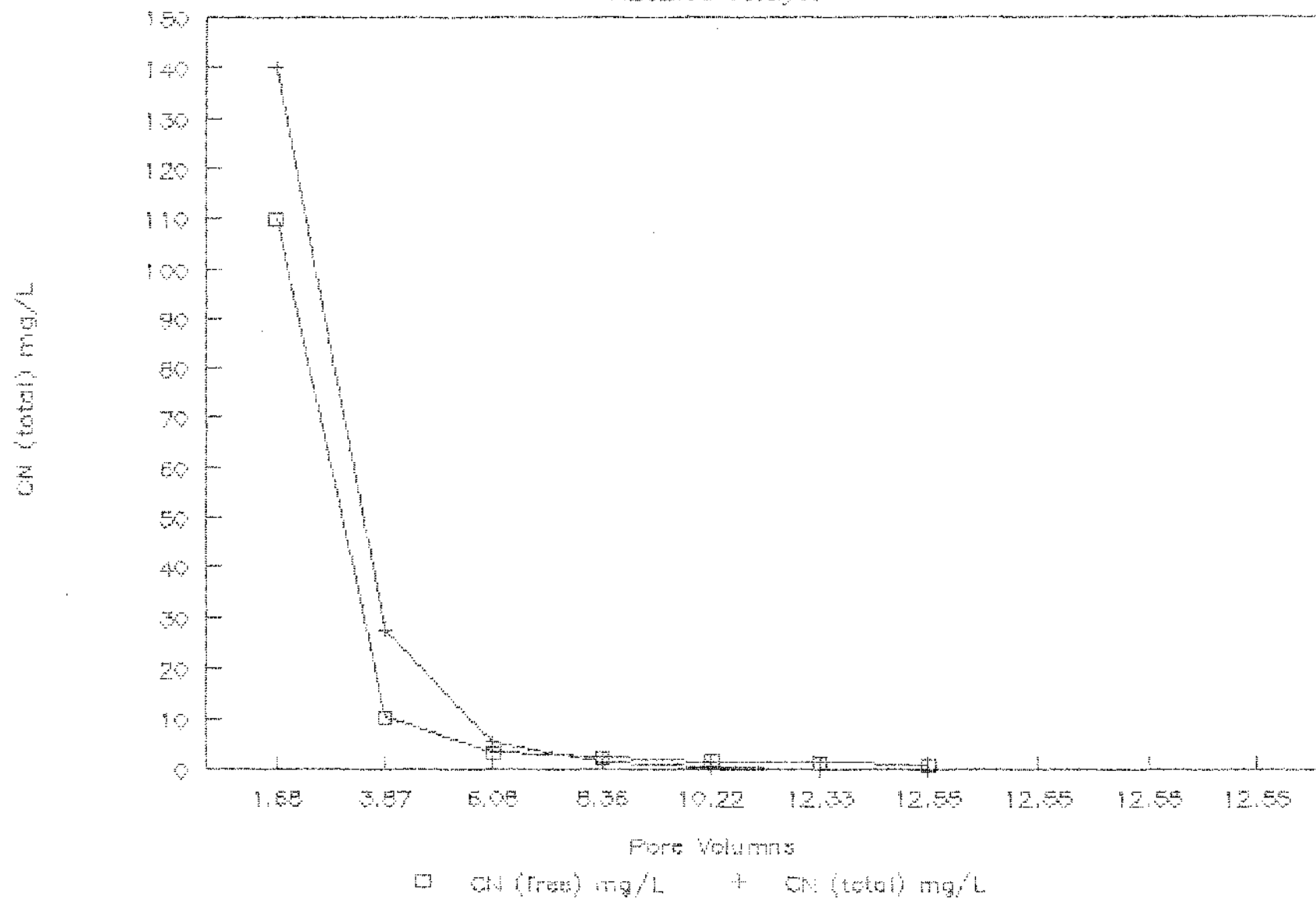
Nevada Goldfield Inc.  
Column Test Results (Detoxification)

Date: 4 Sept 91  
Column #: 2  
Wet wt. (Kg): 38.36  
Moisture %: 19.6  
Dry wt. (Kg): 30.84  
P.V. (Kg): 4.23

Days #	Applied Kg	Collected Kg	Collected Cum. Kg	P.V. #	P.V. Cum.	pH	CN (free) mg/L	CN (total) mg/L
1	9.94	7.1	7.1	1.68	1.68	10.5	110	140
2	9.98	9.29	16.39	2.20	3.87	10.8	10.3	27.5
3	9.28	9.33	25.72	2.21	6.08	10.9	3.5	5.41
4	10.8	9.63	35.35	2.28	8.36	10.8	2.6	1.7
5	7.7	7.9	43.25	1.87	10.22	10.7	1.9	0.65
6	9.2	8.9	52.15	2.10	12.33	10.3	1.6	0.1
7	0	0.95	53.1	0.22	12.55	7	1.03	0.07
8			53.1	0.00	12.55			
9			53.1	0.00	12.55			
10			53.1	0.00	12.55			
Totals:	56.9	53.1		12.55				

# Column 2

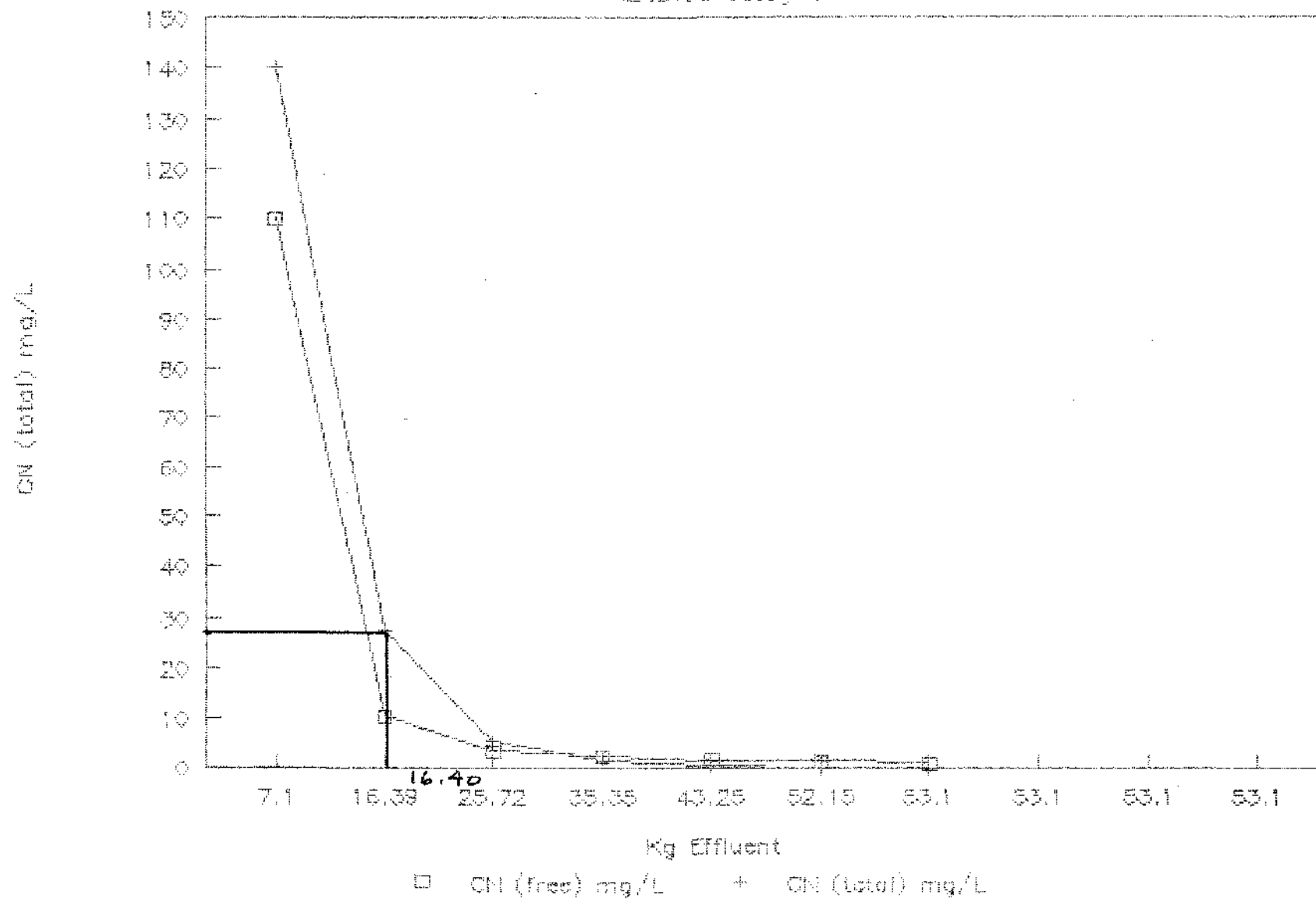
H2O2:Cu catalyst





# Column 2

H2O2:Cu catalyst



B18

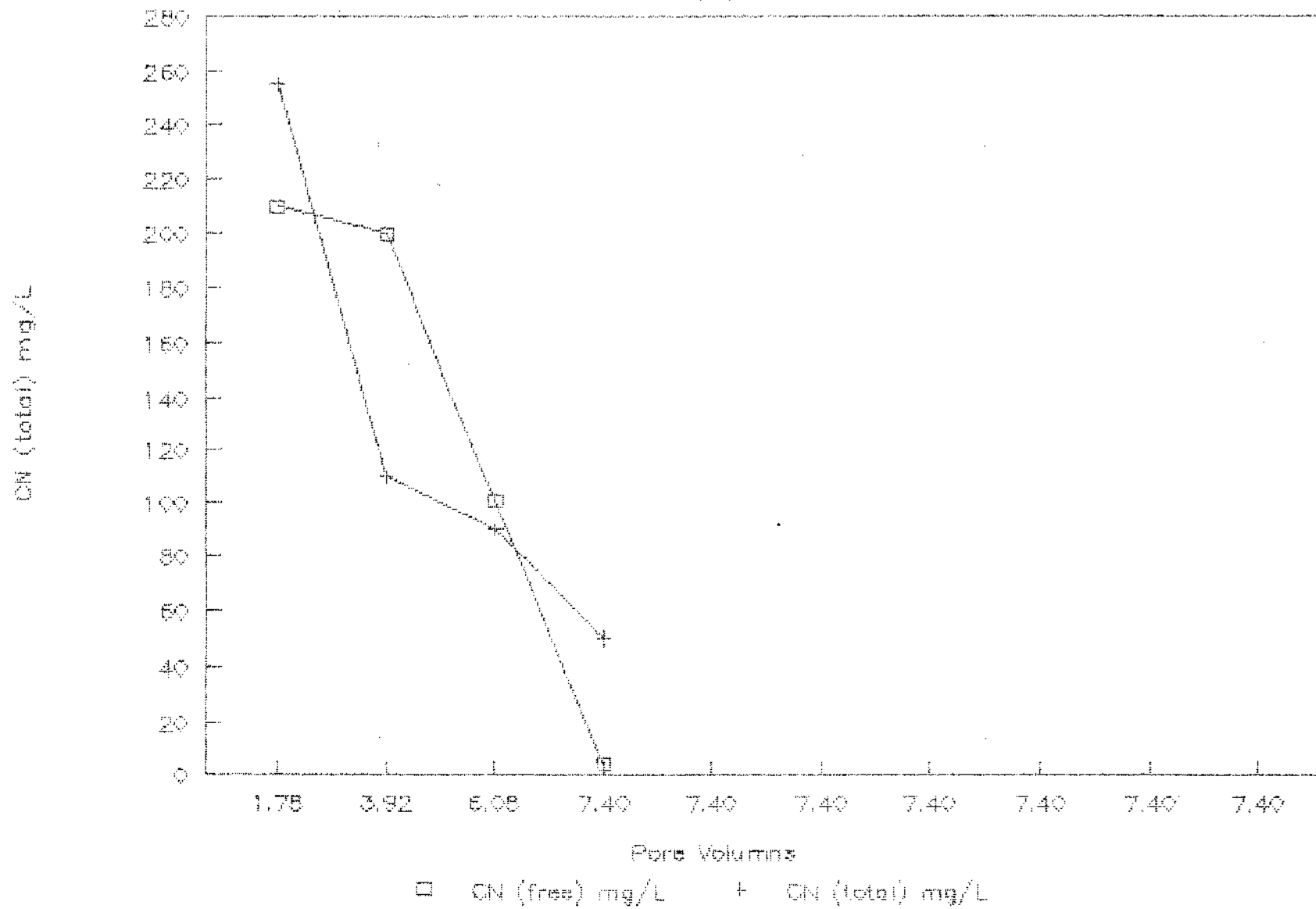
Nevada Goldfield Inc.  
Column Test Results (Detoxification)

Date: 4 Sept 91  
Column #: 3  
Net wt. (Kg): 39.95  
Moisture %: 19.6  
Dry wt. (Kg): 32.12  
P.V. (Kg): 4.4

Days #	Applied Kg	Collected Kg	Collected Cum. Kg	P.V. #	P.V. Cum.	pH	CN (free) mg/L	CN (total) mg/L
1	9.71	7.85	7.85	1.78	1.78	10.7	210	255
2	10.24	9.4	17.25	2.14	3.92	10.5	200	110
3	10.04	9.5	26.75	2.16	6.08	10.4	101	90
4	0	5.8	32.55	1.32	7.40	8	4.3	50
5			32.55	0.00	7.40			
6			32.55	0.00	7.40			
7			32.55	0.00	7.40			
8			32.55	0.00	7.40			
9			32.55	0.00	7.40			
10			32.55	0.00	7.40			
Totals:	29.99	32.55		7.40				

# Column 3

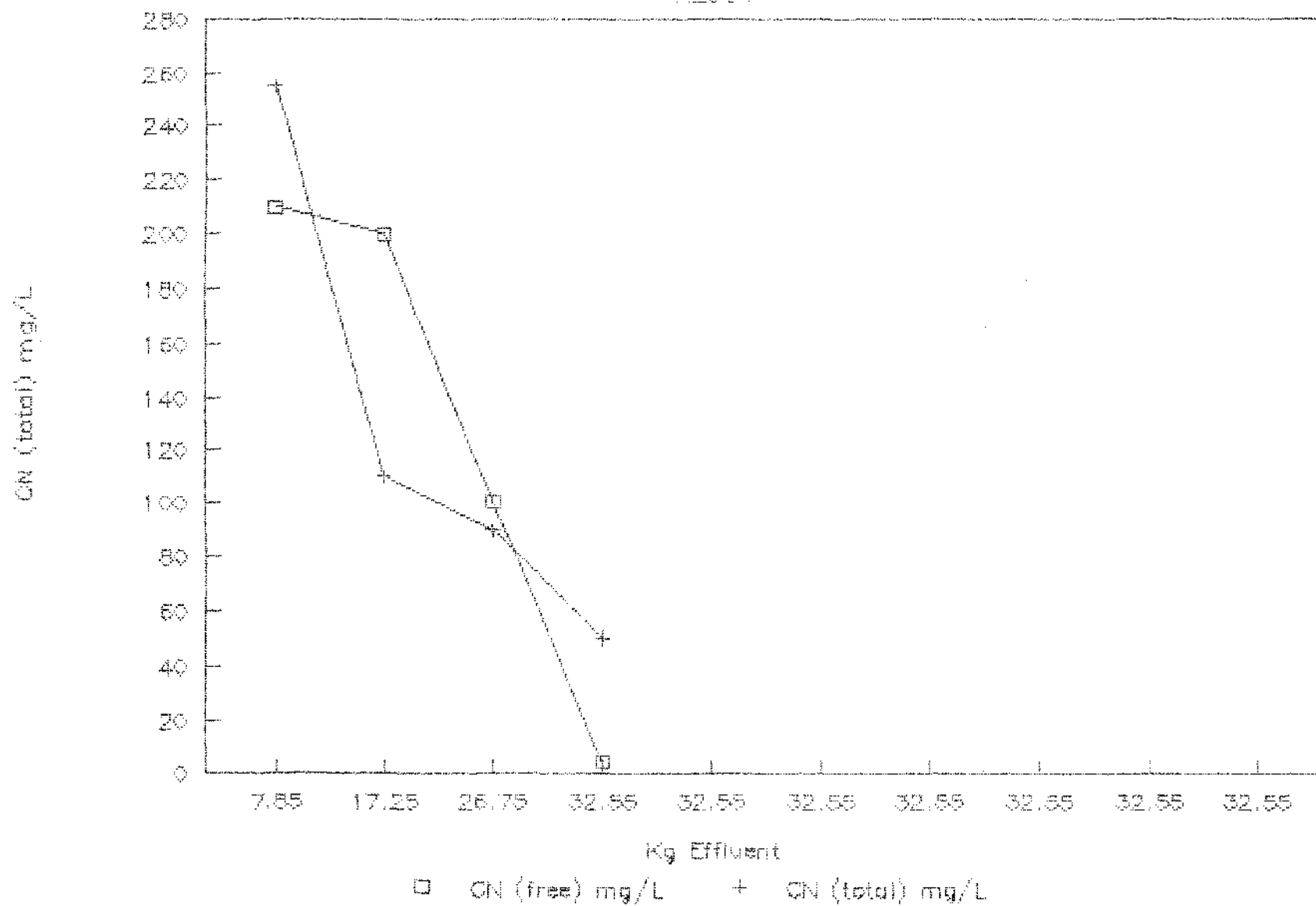
H2504



B20

# Column 3

H2304



B21

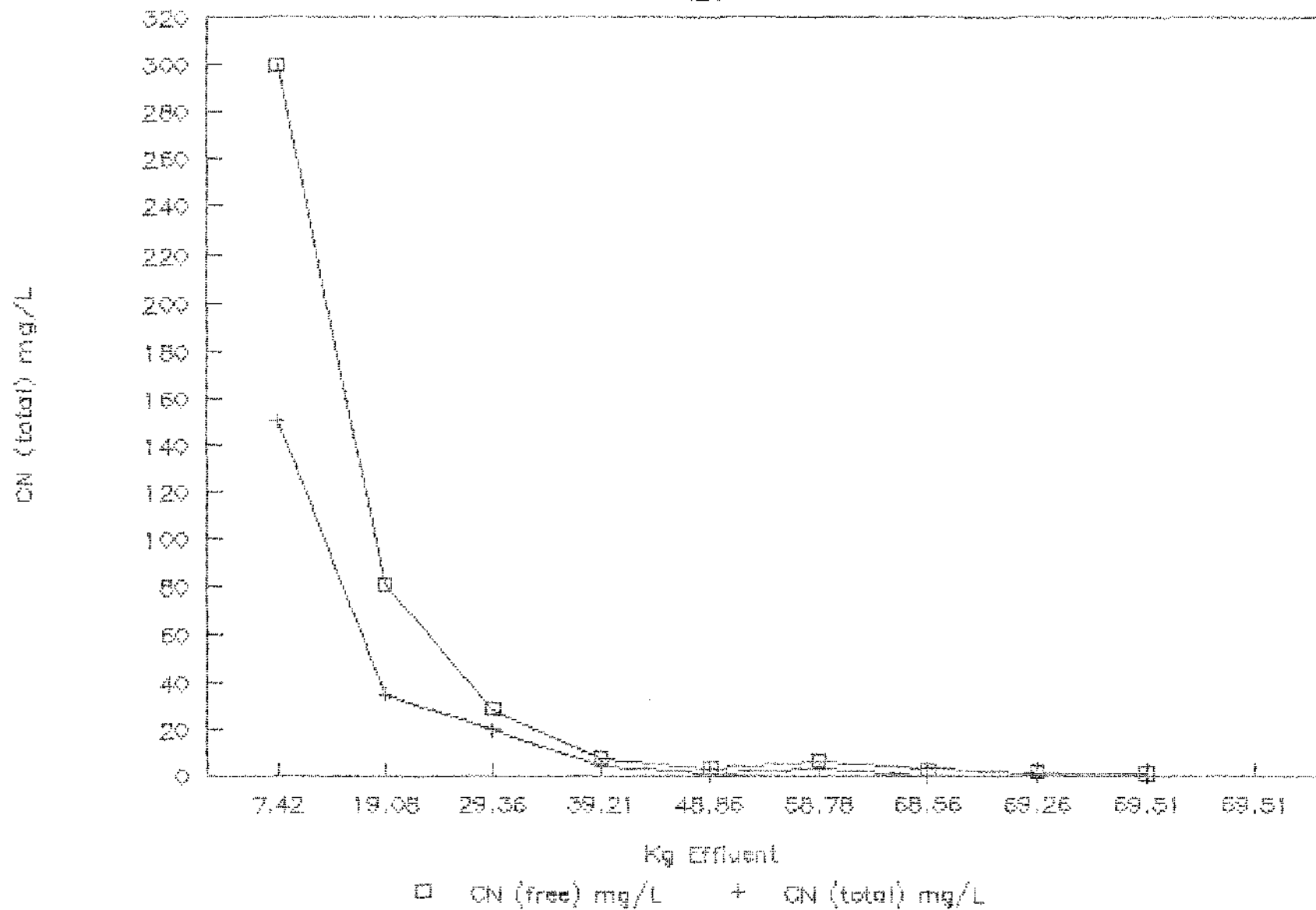
Nevada Goldfield Inc.  
Column Test Results (Detoxification)

Date: 19 Sept 91  
Column #: 4  
Net wt. (Kg): 42.73  
Moisture %: 14.8  
Dry wt. (Kg): 36.41  
P.V. (Kg): 5.37

Days #	Applied Kg	Collected Kg	Collected Cum. Kg	P.V. #	P.V. Cum.	pH	CN (free) mg/L	CN (total) mg/L
1	9.28	7.42	7.42	1.38	1.38	11.2	300	150
2	10.72	11.66	19.08	2.17	3.55	11.3	81	35.5
3	10	10.28	29.36	1.91	5.47	10.8	29	20
4	10	9.85	39.21	1.83	7.30	10.7	8.1	4.5
5	10	9.65	48.86	1.80	9.10	10.5	4	1.5
6	10	9.92	58.78	1.85	10.95	11.1	7	4
7	10	9.78	68.56	1.82	12.77	10.5	3.5	0.17
8	0.67	0.7	69.26	0.13	12.90	8.8	1.8	0.22
9	0	0.25	69.51	0.05	12.94	8.8	1.5	0.22
10			69.51	0.00	12.94			
Totals:	70.67	69.51			12.94			

# Column 4

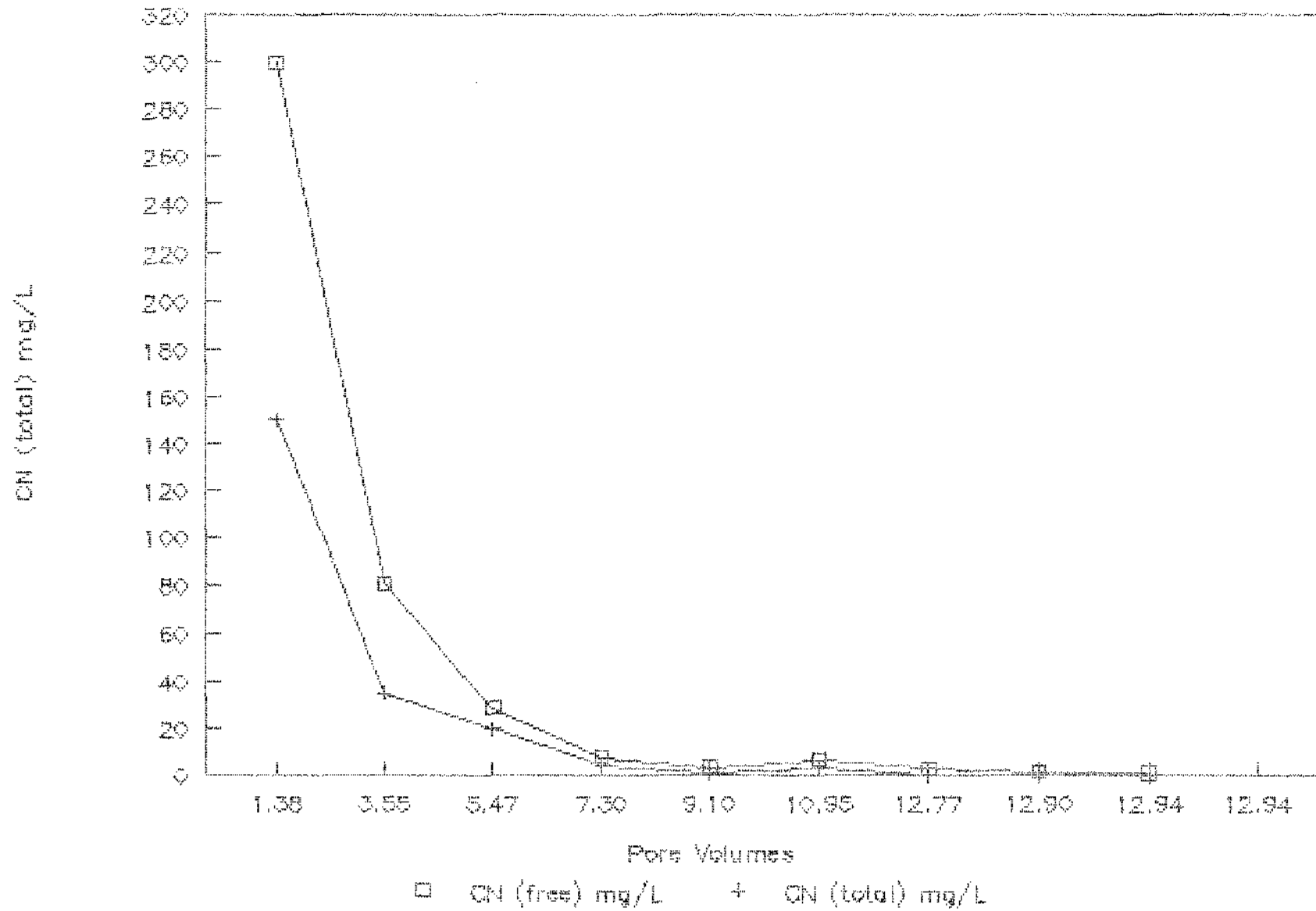
H2O2



B23

# Column 4

H2O2



B24

Nevada Goldfield Inc.  
Column Test Results (Detoxification)

Date: 19 Sept 91  
Column #: 5  
Net wt. (Kg): 44.545  
Moisture %: 14.8  
Dry wt. (Kg): 37.955  
P.V. (Kg): 5.82

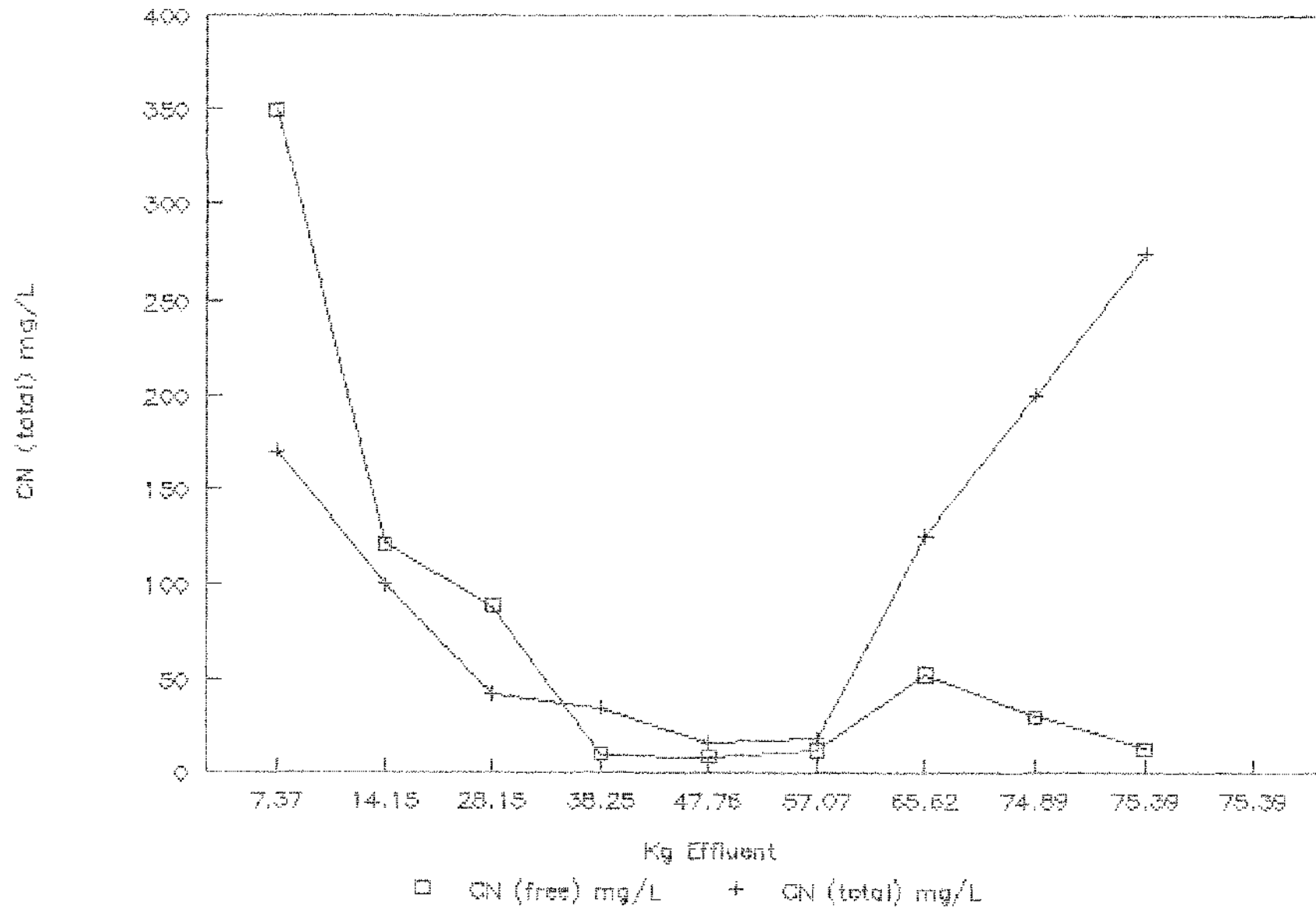
Days #	Applied Kg	Collected Kg	Collected Cum. Kg	P.V. #	P.V. Cum.	pH	CN (free) mg/L	CN (total) mg/L
1	8.29	7.37	7.37	1.27	1.27	10.8	350	170
2	6.94	6.78	14.15	1.16	2.43	11.2	121	100
3	14.77	14	28.15	2.41	4.84	11	89	42.5
4	10	10.1	38.25	1.74	6.57	10.7	10.1	35
5	10	9.51	47.76	1.63	8.21	9.8	9	17
6	10	9.31	57.07	1.60	9.81	11.1	12.3	18.5
7	8.76	8.55	65.62	1.47	11.27	11	53	125
8	9.68	9.27	74.89	1.59	12.87	10.7	30.4	200
9	0	0.5	75.39	0.09	12.95	10.5	13	275
10			75.39	0.00	12.95			
Totals:	78.44	75.39		12.95				

B25



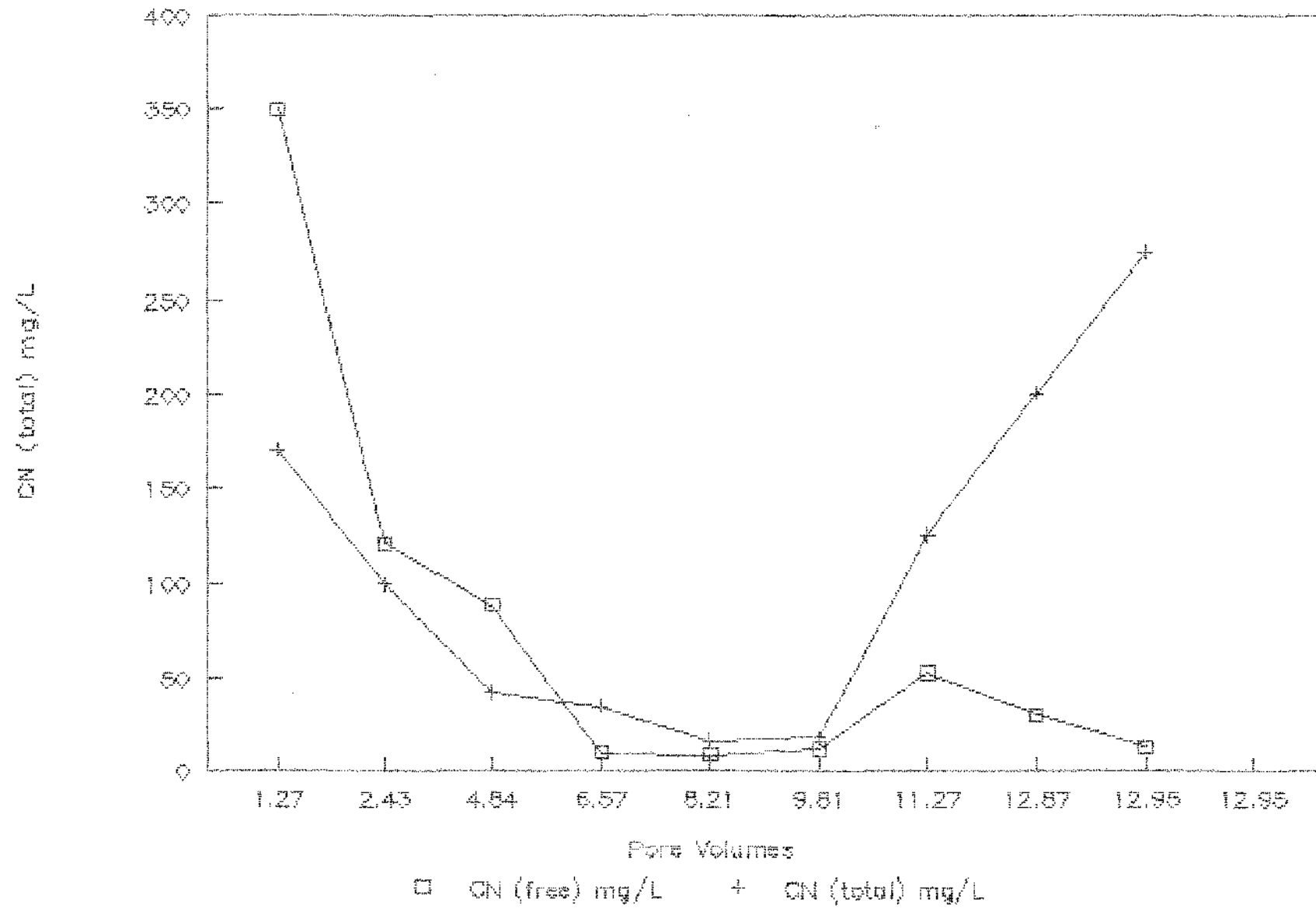
# Column 5

FeSO<sub>4</sub>



# Column 5

FeSO<sub>4</sub>



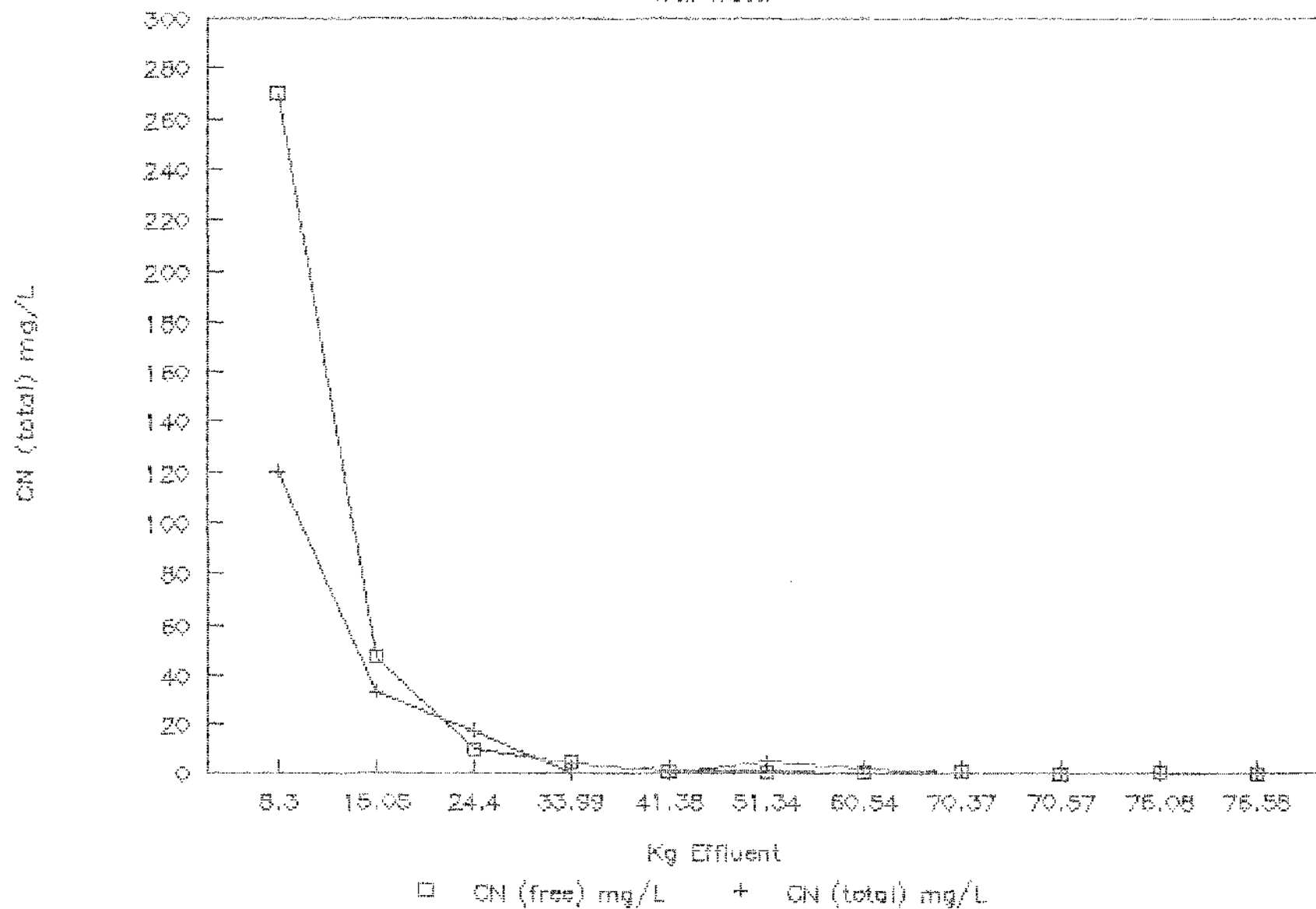
Nevada Goldfield Inc.  
Column Test Results (Detoxification)

Date: 19 Sept 91  
Column #: 6  
Wet wt. (Kg): 43.15  
Moisture %: 14.8  
Dry wt. (Kg): 36.76  
P.V. (Kg): 5.85

Days #	Applied Kg	Collected Kg	Collected Cum. Kg	P.V. #	P.V. Cum.	pH	CN (free) mg/L	CN (total) mg/L
1	8.35	8.3	8.3	1.42	1.42	10.8	270	120
2	7.44	6.75	15.05	1.15	2.57	11.3	47	93
3	10	9.95	24.4	1.60	4.17	11.1	10	17.5
4	10	9.59	33.99	1.64	5.81	10.8	4.6	0.3
5	8.5	7.39	41.38	1.26	7.07	10.6	1.03	0.125
6	10	9.96	51.34	1.70	8.78	11.4	1.2	5.2
7	10	9.2	60.54	1.57	10.35	11.3	0.8	2.5
8	9.95	9.83	70.37	1.68	12.03	11.1	0.73	0.65
9	0	0.2	70.57	0.03	12.06	10.4	0.3	0.28
10	5.37	5.51	76.08	0.94	13.01	10.2	0.68	0.28
11	0	0.5	76.58	0.09	13.09	10	0.34	0.19
Totals:	79.61	76.58		13.09				

# Column 6

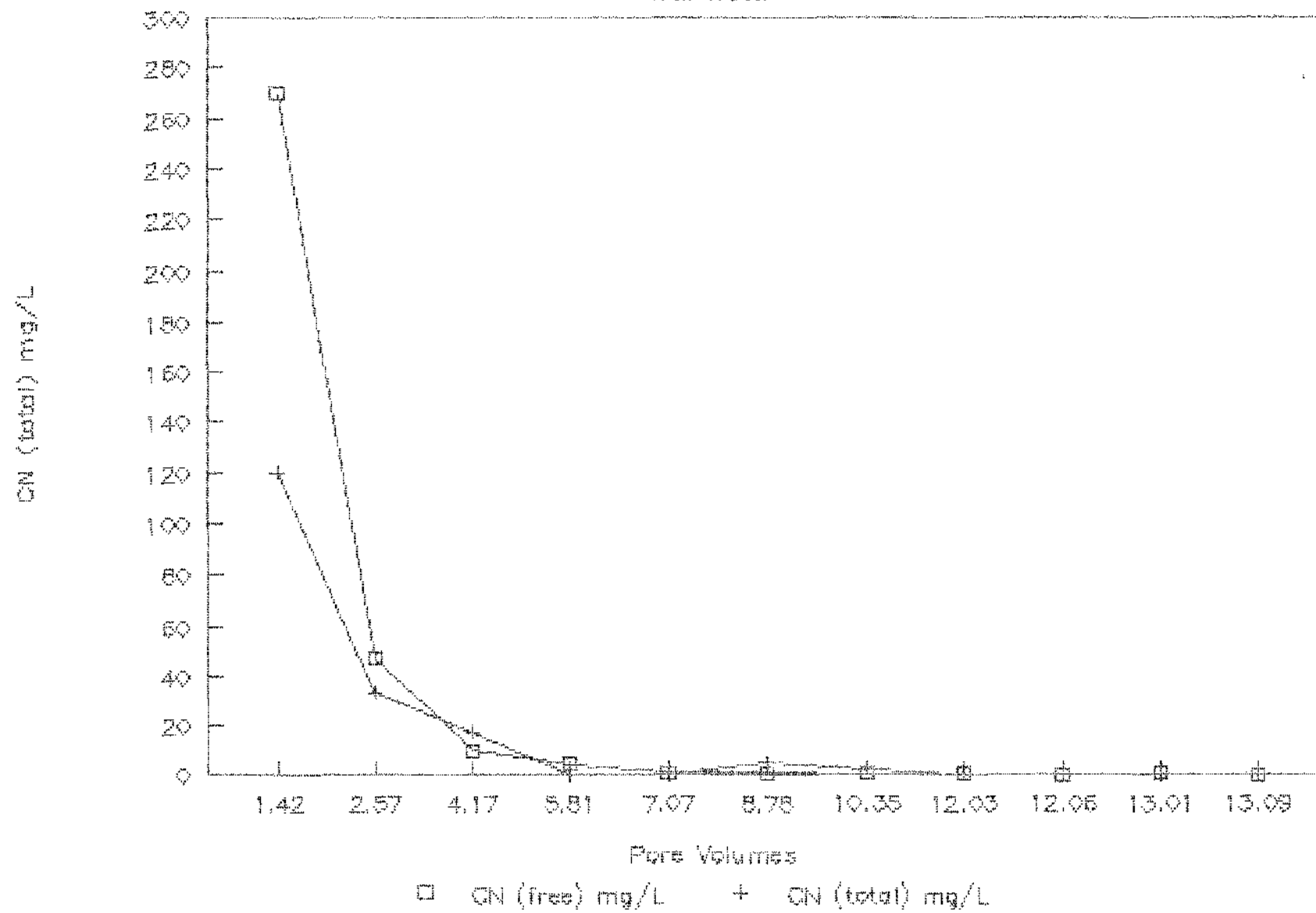
Well Water



B29

# Column 6

Well Water



B30

APPENDIX C  
COLUMN TEST SOIL ANALYSIS

# SHEALY ENVIRONMENTAL SERVICES, INC.

BIOLOGISTS, TOXICOLOGISTS & CHEMISTS

400 GRAYMONT AVENUE  
COLUMBIA, SOUTH CAROLINA 29205  
(803) 254-9915

SC DHEC CERTIFICATION NO. 26103  
NC DEM NO. 001  
Fax (803) 254-9107

## CERTIFICATE OF ANALYSIS

=====

CLIENT: NEVADA GOLD  
P.O. Box 1510  
McCormick, SC 29835

ATTENTION: Mr. Rick Dye

-----

Laboratory I.D. Sample Description

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91-9503	Column 4 upper
91-9504	Column 4 lower
91-9505	Column 5 upper
91-9506	Column 5 lower
91-9507	Column 6 upper
91-9508	Column 6 lower

Date Received: 09/27/91  
Date Reported: 10/04/91  
Date Revised: 10/09/91  
Date Revised: 11/04/91

QA/QC Officer MSA

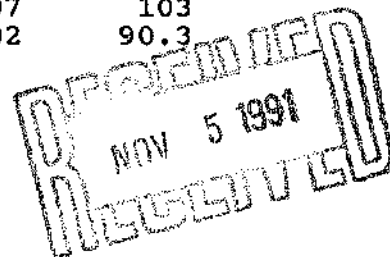
### Results

Parameter	Units	91-9503	TCLP Spike % Rec.	91-9504	TCLP Spike % Rec.
Cyanide - Total	mg/kg	1.3		<1.0	
Cyanide - WAD	mg/kg	2.23		<1.0	
TCLP METALS	mg/l				
Arsenic		0.028	98.3	0.027	90.5
Barium		0.985	88.8	1.19	65.0
Cadmium		<0.001	72.8	<0.001	63.0
Chromium		0.006	97.8	0.003	89.0
Lead		<0.011	102	0.162	138
Mercury		<0.001	106	<0.001	100
Selenium		0.107	103	0.128	92.0
Silver		<0.002	94.0	<0.002	76.5

Parameter	Units	91-9505	TCLP Spike % Rec.	91-9506	TCLP Spike % Rec.
Cyanide - Total	mg/kg	8.5		8.7	
Cyanide - WAD	mg/kg	3.32		5.59	
TCLP METALS	mg/l				
Arsenic		0.012	105	0.023	101
Barium		0.691	102	0.671	89.0
Cadmium		<0.001	72.3	<0.001	67.8
Chromium		<0.003	94.0	<0.003	94.0
Lead		0.045	64.3	0.108	73.5
Mercury		<0.001	99.1	<0.001	101
Selenium		0.104	106	0.107	103
Silver		<0.002	83.3	<0.002	90.3

Continued on Page 2

B32



CLIENT:  
Date Reported:  
Date Revised:  
Date Revised:

NEVADA GOLD  
10/04/91  
10/09/91  
11/04/91

Page 2

Results

Parameter	Units	TCLP Spike		TCLP Spike	
		91-9507	% Rec.	91-9508	% Rec.
Cyanide - Total	mg/kg	1.1		1.8	
Cyanide - WAD	mg/kg	<1.0		<1.0	
TCLP METALS	mg/l				
Arsenic		0.021	102	0.019	107
Barium		2.54	85.0	1.38	75.0
Cadmium		<0.001	72.5	<0.001	70.5
Chromium		<0.003	69.8	<0.003	98.8
Lead		0.355	17.8	0.042	91.0
Mercury		<0.001	83.3	<0.001	91.0
Selenium		0.103	96.5	0.110	104
Silver		<0.002	91.0	<0.002	86.8

Parameter	Units	Date	
		Analyst	Analyzed
Cyanide - Total	mg/l	RES	10/02/91
Cyanide - WAD	mg/l	RES	10/03/91
TCLP METALS	mg/l	VTB	10/03/91
Arsenic			
Barium			
Cadmium			
Chromium			
Lead			
Mercury			
Selenium			
Silver			

Reported By: 

Michael A. Woodrum, Laboratory Director



# SHEALY ENVIRONMENTAL SERVICES, INC.

BIOLOGISTS, TOXICOLOGISTS & CHEMISTS

400 GRAYMONT AVENUE  
COLUMBIA, SOUTH CAROLINA 29205  
(803) 254-9915

SC DHEC CERTIFICATION NO. 26103  
NC DEM NO. 001  
Fax (803) 254-9107

## CERTIFICATE OF ANALYSIS

### CLIENT:

NEVADA GOLD  
P.O. Box 1510  
McCormick, SC 29835

### ATTENTION:

Mr. Rick Dye

### Laboratory I.D.

### Sample Description

91-9503	Column 4 upper: Add-ons
91-9504	Column 4 lower: Add-ons
91-9505	Column 5 upper: Add-ons
91-9506	Column 5 lower: Add-ons
91-9507	Column 6 upper: Add-ons
91-9508	Column 6 lower: Add-ons

Date Received:

09/27/91

Date Reported:

10/22/91

QA/QC Officer *MCW*

### Results

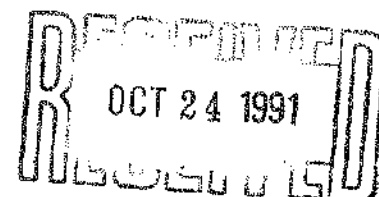
Parameter	Units	91-9503	91-9504	91-9505	91-9506
Sulfide	mg/kg	<50	<50	<50	<50
TCLP METALS	mg/l				
Copper		<0.200	<0.200	<0.200	<0.200
Zinc		<0.200	<0.200	<0.200	<0.200

Parameter	Units	91-9507	91-9508	Analyst	Date Analyzed
Sulfide	mg/kg	<50	<50	TMW	10/14/91
TCLP METALS	mg/l			VTB	10/03/91
Copper		<0.200	<0.200		
Zinc		<0.200	<0.200		

Reported By: *Michael A. Woodrum*

Michael A. Woodrum, Laboratory Director

MAW/rbh



B34

Fax: (803)229-7844

SP/SEC

PROJ. NO.		PROJECT NAME		SAMPLERS NAME/AFFILIATION:(PRINTED)		NO. OF CONTAINERS	PARAMETERS										SAMPLE TYPE	POTENTIAL HAZARD	
SAMPLE NO.	DATE	TIME	COMP.	GRAB	SAMPLE DESCRIPTION												REMARKS		
16.			✓		COLUMN 4 UPPER	1	<div style="writing-mode: vertical-rl; transform: rotate(180deg);">           CN- (Total: WND)            Metal -            same as            solution            samples            Ag            the same            detection            limits         </div>										91-9503	SD	
17					COLUMN 4 LOWER	1											91-9504	1	
18					COLUMN 5 UPPER	1											91-9505		
19					COLUMN 5 LOWER	1											91-9506		
20					COLUMN 6 UPPER	1											91-9507		
21					COLUMN 6 LOWER	1											91-9508	✓	
					<u>ICLP</u> for the extract <div style="text-align: center;"> <div style="border-bottom: 1px solid black; width: 50px; margin: 0 auto;"></div> <div style="border-bottom: 1px solid black; width: 50px; margin: 0 auto;"></div> <div style="border-bottom: 1px solid black; width: 50px; margin: 0 auto;"></div> </div>														
RELINQUISHED BY: (SIGNATURE)		DATE / TIME		RECEIVED BY: (SIGNATURE)		RELINQUISHED BY: (SIGNATURE)		DATE / TIME		RECEIVED BY: (SIGNATURE)									
RELINQUISHED BY: (SIGNATURE)		DATE / TIME		RECEIVED FOR LAB BY: (SIGNATURE)		DATE / TIME		REMARKS											
DW-DRINKING WATER GW-GROUND WATER		WW-WASTE WATER RC-RCRA		HW-HAZARDOUS WASTE SW-SURFACE WATER		SD-SOLID IM-IMPINGER SOLUTION		AD-ABSORBENT TUBE											

B35

Push-Red by Oct. 4<sup>th</sup>

**Davis & Floyd, Inc.**

Laboratory Analysis Report

Page 1

Work Order # 91-09-031

Received: 09/06/91

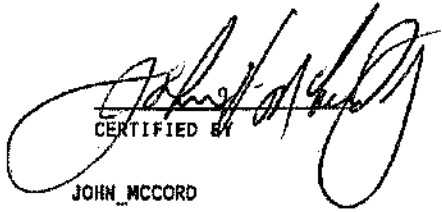
09/25/91 10:34:00

REPORT GWALIA USA LIMITED  
TO P.O. BOX 1510  
McCORMICK, S. C. 29835

PREPARED Davis & Floyd, Inc.  
BY P.O. Drawer 428  
Greenwood, S.C. 29648

ATTEN SCOTT WILKINSON

PHONE (803)-229\_5211

  
CERTIFIED BY  
JOHN MCCORD

WORK ID JOB NO. 7623.00

P.O. #

TAKEN S. WILKINSON

TYPE SOLID WASTE

NUMBER OF SAMPLES 6

**Comments:**

WE ARE PLEASED TO PROVIDE THIS CERTIFIED REPORT OF ANALYSES.  
FEEL FREE TO TELEPHONE IF FURTHER EXPLANATION IS REQUIRED.  
UNLESS OTHER ARRANGEMENTS HAVE BEEN MADE, SAMPLES WILL BE  
DISPOSED OF OR RETURNED 28 DAYS FROM THE DATE OF THIS REPORT.

**SAMPLE IDENTIFICATION**

01 COLUMN #1 UPPER  
02 COLUMN #1 LOWER  
03 COLUMN #2 UPPER  
04 COLUMN #2 LOWER  
05 COLUMN #3 UPPER  
06 COLUMN #3 LOWER

**DATE COLLECTED**

09/03/91 08:00:00  
09/03/91 08:00:00  
09/03/91 08:00:00  
09/03/91 08:00:00  
09/03/91 08:00:00  
09/03/91 08:00:00

**RECEIVED**  
SEP 26 1991  
**RECEIVED**

## Davis &amp; Floyd, Inc.

## Laboratory Analysis Report

Page 2

Work Order # 91-09-031

Received: 09/06/91

09/25/91 10:34:00

Test Description	Units	01	02	03	04
		COLUMN #1 UPP- ER	COLUMN #1 LOW- ER	COLUMN #2 UPP- ER	COLUMN #2 LOW- ER
SILVER (TOTAL)	mg/l	0.015	<0.010	<0.010	<0.010
BARIUM (TOTAL)	mg/l	1.13	0.97	1.25	1.09
CADMIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	<0.01	<0.01	<0.01	<0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.04	0.02	<0.02	0.02
ZINC (TOTAL)	mg/l	0.07	0.05	0.04	0.09
MERCURY (TOTAL)	mg/l	0.0024	0.0007	<0.0002	<0.0002
ARSENIC (TOTAL)	mg/l	<0.05	<0.05	<0.05	<0.05
LEAD (TOTAL)	mg/l	<0.05	<0.05	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.05	<0.05	<0.05	<0.05
CHLORINE RESIDUAL	mg/l	0.13	<0.1	0.15	0.1
SULFIDE	mg/l	0.10	0.10	0.10	0.08
CYANIDE (TOTAL)	mg/l	0.334	0.290	0.479	0.233
CYANIDE (WAD)	mg/l	0.066	0.048	0.053	0.034

Test Description	Units	05	06
		COLUMN #3 UPP- ER	COLUMN #3 LOW- ER
SILVER (TOTAL)	mg/l	<0.010	<0.010
BARIUM (TOTAL)	mg/l	0.17	0.29
CADMIUM (TOTAL)	mg/l	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	<0.01	<0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.03	<0.02
ZINC (TOTAL)	mg/l	0.06	0.04

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**Davis & Floyd, Inc.**

Laboratory Analysis Report

Page 3

Received: 09/06/91

09/25/91 10:34:00

Work Order # 91-09-031

Continued From Above

Test Description	Units	05	06
		COLUMN #3 UPP- ER	COLUMN #3 LOW- ER
MERCURY (TOTAL)	mg/l	0.0012	0.0016
ARSENIC (TOTAL)	mg/l	<0.05	<0.05
LEAD (TOTAL)	mg/l	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.05	<0.05
CHLORINE RESIDUAL	mg/l	<0.1	<0.1
SULFIDE	mg/l	0.10	0.10
CYANIDE (TOTAL)	mg/l	0.379	0.774
CYANIDE (WAD)	mg/l	0.239	0.440

B38

# DAVIS & FLOYD

## Chain of Custody Form

816 East Durst Street, Greenwood, S.C. 29649

Phone (803)229-5211

Fax (803)229-7119

Page 1 of 1

PROJ. NO.		PROJECT NAME		NO. OF BOTTLES		PARAMETERS												REMARKS	SAMPLE TYPE	POTENTIAL HAZARD
SAMPLERS NAME/AFFILIATION:(PRINTED)																				
		Novada Goldfields Inc. (GWAALYA)																		
		BARITE HILL																		
Scott A. Wilkinson																				
SAMPLE NO.	DATE	TIME	GRAB	COMP	SAMPLE DESCRIPTION															
1	9-3	0800		X	COLUMN 1 - UPPER															
2				X	COLUMN 1 - LOWER															
3				X	COLUMN 2 - UPPER															
4				X	COLUMN 2 - LOWER															
5				X	COLUMN 3 - UPPER															
6	✓	✓		X	COLUMN 3 - LOWER															
<p>RUSH cyanide please</p>																				
RELINQUISHED BY: (SIGNATURE)			DATE / TIME			RECEIVED BY: (SIGNATURE)			RELINQUISHED BY: (SIGNATURE)			DATE / TIME			RECEIVED BY: (SIGNATURE)					
X Scott A. Wilkinson			9-5-91 10:30																	
RELINQUISHED BY: (SIGNATURE)			DATE / TIME			RECEIVED FOR LAB BY: (SIGNATURE)			DATE / TIME			REMARKS								
						John M. Ford			9-5-91 10:30											
DW-DRINKING WATER GW-GROUND WATER			WW-WASTE WATER RC-RCRA			HW-HAZARDOUS WATER SW-SURFACE WATER			SD-SOLID IM-IMPINGER SOLUTION			AB-ABSORBENT TUBE								

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9109031

APPENDIX D

DAILY FLOW, CN, pH OF CELL 6 HEAP TEST

APPENDIX D

DAILY FLOW, CN, pH OF CELL 6 HEAP TEST



Nevada Goldfield Inc.  
Cell Detoxification

Cell: 6

Date: Nov. 15 91

Nos. Days	Date	CN WAD mg/L	pH	Flow GPD	CN lbs.
1	04-Oct-91	205	11.4	172900	295.44
2	05-Oct-91	189	11.4	131040	200.00
3	06-Oct-91	195	11.4	113760	185.01
4	07-Oct-91	151	11.4	113760	143.26
5	08-Oct-91	150	11.4	89280	111.69
6	09-Oct-91	147	11.4	101520	124.46
7	10-Oct-91	163	11.4	54720	74.39
8	11-Oct-91	141	11.4	36000	42.33
9	12-Oct-91	130	11.4	79200	85.87
10	13-Oct-91	120	11.4	89712	89.78
11	14-Oct-91	103	11.4	82080	70.51
12	15-Oct-91	105	11.4	72000	63.05
13	16-Oct-91	90	11.4	74880	56.20
14	17-Oct-91	90	11.4	67680	50.80
15	18-Oct-91	95	11.4	41760	33.09
16	19-Oct-91	85	11.4	41817	29.64
17	20-Oct-91	75	11.4	41817	26.16
18	21-Oct-91	63	11.4	54144	28.45
19	22-Oct-91	75	11.4	67680	42.33
20	23-Oct-91	70	11.4	67680	39.51
21	24-Oct-91	63	11.4	67680	35.56
22	25-Oct-91	72	11.4	64080	38.48
23	26-Oct-91	50	11.4	74880	31.22
24	27-Oct-91	45	11.4	74880	28.10
25	28-Oct-91	45	11.4	106560	39.99
26	29-Oct-91	40	11.4	106560	35.55
27	30-Oct-91	40	11.4	106560	35.55
28	31-Oct-91	32	11.5	105120	28.05
29	01-Nov-91	32	11.4	36000	9.61
30	02-Nov-91	40	11.6	8712	2.91
31	03-Nov-91	40	11.5	5587	1.86
32	04-Nov-91	40	10.9	1022	0.34
33	05-Nov-91	37	11.3	1022	0.32
34	06-Nov-91	31	11.2	60768	15.71
35	07-Nov-91	42	11.1	97560	34.17
36	08-Nov-91	62	11	82109	42.46

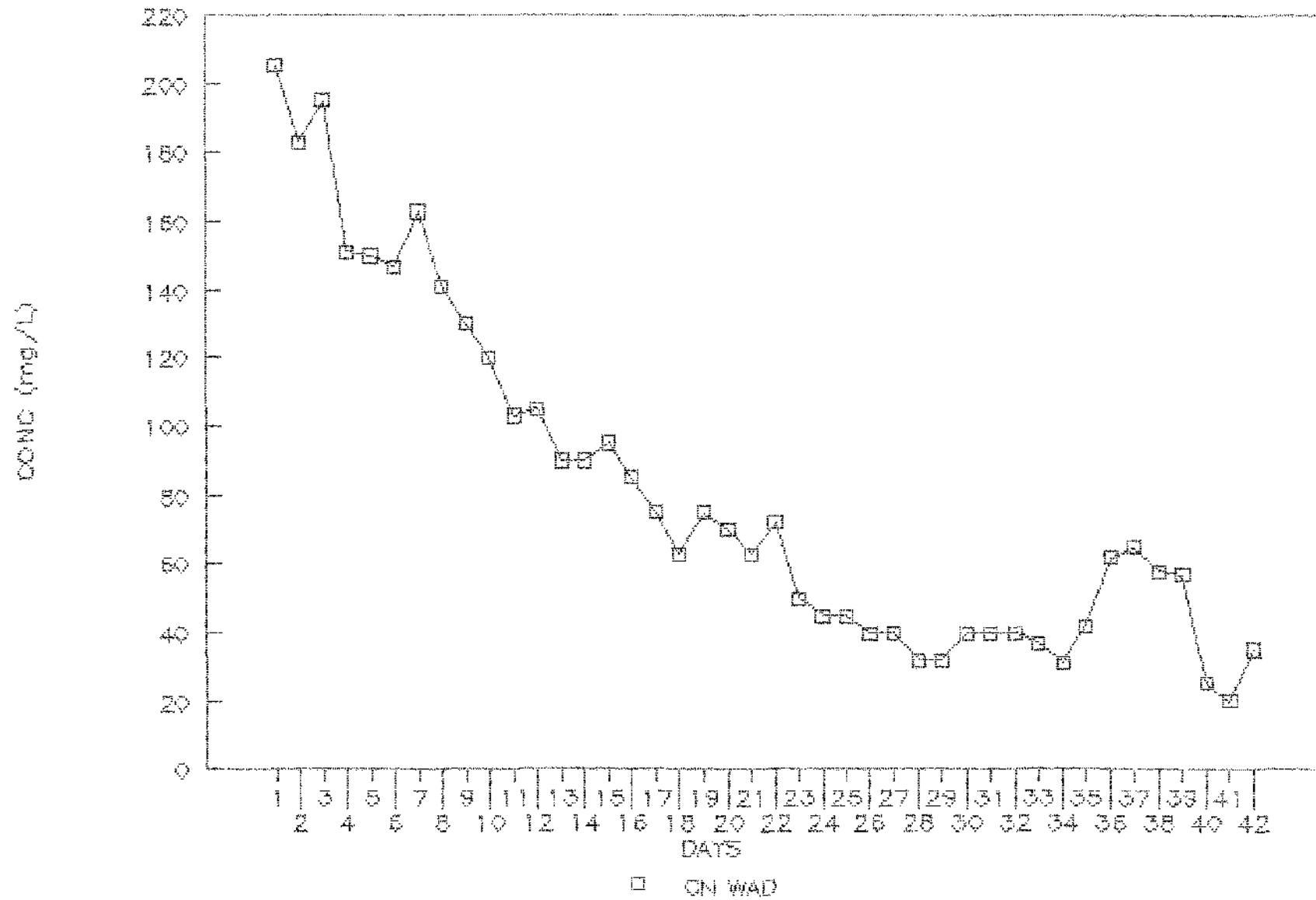
B42

Nevada Goldfield Inc.  
Cell Detoxification

Cell: 6  
Date: Nov. 15 91

Nos. Days	Date	CN WPD mg/L	pH	Flow GPD	CN lbs.
37	09-Nov-91	65	11	113760	61.67
38	10-Nov-91	58	11.2	109440	52.94
39	11-Nov-91	57	11.2	97560	46.38
40	12-Nov-91	25	11.3	89712	18.70
41	13-Nov-91	20	11.2	67680	11.29
42	14-Nov-91	35	11.4	47520	13.87
TOTALS:				3118102.00	2376.71

# CELL 6



B44

APPENDIX E  
LABORATORY RESULTS OF CELL 6 RESIDUE SAMPLES

B45

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 1

Work Order # 91-12-034

Received: 12/05/91

12/20/91 11:31:45

REPORT NEVADA GOLDFIELDS, INC.  
TO P.O. BOX 1530  
McCORMICK, SC 29835

PREPARED Davis & Floyd, Inc.  
BY P.O. Drawer 428  
Greenwood, S.C. 29648

ATTEN SCOTT WILKINSON

PHONE (803)-229\_5211

CERTIFIED BY

JOHN MCCORD

WORK ID JOB NO. 7623.00

P.O. #

TAKEN NEVADA GOLDFIELDS, INC.

TYPE SOLID

NUMBER OF SAMPLES 10

Comments:

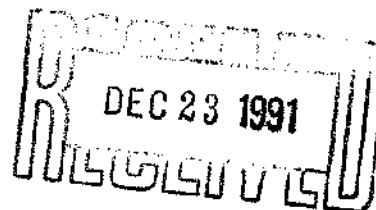
WE ARE PLEASED TO PROVIDE THIS CERTIFIED REPORT OF ANALYSES.  
FEEL FREE TO TELEPHONE IF FURTHER EXPLANATION IS REQUIRED.  
UNLESS OTHER ARRANGEMENTS HAVE BEEN MADE, SAMPLES WILL BE  
DISPOSED OF OR RETURNED 28 DAYS FROM THE DATE OF THIS REPORT.

SAMPLE IDENTIFICATION

DATE COLLECTED

01 CELL #1-#3 0-5  
02 CELL #1-#3 5-10  
03 CELL #1-#3 10-15  
04 CELL #1-#3 15-20  
05 CELL #2-#3 0-5A  
06 CELL #2-#3 0-5B  
07 CELL #2-#3 5-10  
08 CELL #2-#3 10-15  
09 CELL #2-#3 20-25  
10 CELL #2-#3 15-20

TCLP  
Tests



B46

# TCLP Tests

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 2

Work Order # 91-12-034

Received: 12/05/91

12/20/91 11:31:45

Test Description	Units	01	02	03	04
		CELL #1-#3 0- -5	CELL #1-#3 5- -10	CELL #1-#3 1- 0-15	CELL #1-#3 1- 5-20
BARIUM (TOTAL)	mg/l	0.50	0.36	0.72	0.85
CADMIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	<0.01	<0.01	0.01	0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01	<0.01	<0.01
COPPER (TOTAL)	mg/l	<0.01	<0.01	0.02	0.04
ZINC (TOTAL)	mg/l	0.05	0.04	0.05	0.05
MERCURY (TOTAL)	mg/l	<0.0002	<0.0002	0.0006	<0.0002
ARSENIC (TOTAL)	mg/l	<0.005	<0.005	0.005	0.006
LEAD (TOTAL)	mg/l	<0.05	<0.05	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
pH (LAB)	pH units	5	5	5	5
SULFIDE	mg/l	<0.05	<0.05	0.10	<0.05
CYANIDE (TOTAL)	mg/l	0.465	0.550	0.932	0.343
CYANIDE (WAD)	mg/l	0.074	0.073	0.156	0.057

Test Description	Units	05	06	07	08
		CELL #2-#3 0- -5A	CELL #2-#3 0- -5B	CELL #2-#3 5- -10	CELL #2-#3 1- 0-15
BARIUM (TOTAL)	mg/l	0.83	1.03	1.09	1.18
CADMIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	0.01	0.04	0.02	<0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.02	0.03	0.02	<0.01
ZINC (TOTAL)	mg/l	0.03	0.05	0.04	0.04
MERCURY (TOTAL)	mg/l	0.0015	0.0009	0.0013	0.0016
ARSENIC (TOTAL)	mg/l	<0.005	<0.005	<0.005	0.005

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# TCLP Tests

**Davis & Floyd, Inc.**

Laboratory Analysis Report

Page 3

Received: 12/05/91

12/20/91 11:31:45

Work Order # 91-12-034

Continued From Above

Test Description	Units	05	06	07	08
		CELL #2-#3 0- -5A	CELL #2-#3 0- -5B	CELL #2-#3 5- -10	CELL #2-#3 1- 0-15
LEAD (TOTAL)	mg/l	<0.05	<0.05	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
pH (LAB)	pH units	5	5	5	5
SULFIDE	mg/l	<0.05	<0.05	<0.05	<0.05
CYANIDE (TOTAL)	mg/l	0.900	1.384	0.992	1.164
CYANIDE (WAD)	mg/l	0.471	1.112	0.582	0.381

Test Description	Units	09	10
		CELL #2-#3 2- 0-25	CELL #2-#3 1- 5-20
BARIUM (TOTAL)	mg/l	1.23	0.93
CADMIUM (TOTAL)	mg/l	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	<0.01	<0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.02	<0.01
ZINC (TOTAL)	mg/l	0.04	0.04
MERCURY (TOTAL)	mg/l	0.0012	0.0023
ARSENIC (TOTAL)	mg/l	<0.005	<0.005
LEAD (TOTAL)	mg/l	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.012 X	<0.005
pH (LAB)	pH units	5	5
SULFIDE	mg/l	<0.05	0.19
CYANIDE (TOTAL)	mg/l	1.024	2.384
CYANIDE (WAD)	mg/l	0.564	0.308

B48

# TCLP Tests

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 2

Work Order # 91-12-035

Received: 12/05/91

12/20/91 11:35:41

Test Description	Units	01	02	03	04
		CELL #5-#4 0- -5	CELL #5-#4 5- -10	CELL #5-#4 1- 0-15	CELL #6-#5 0- -5
BARIUM (TOTAL)	mg/l	0.56	1.21	0.97	0.92
CADMIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	<0.01	<0.01	0.01	<0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01	<0.01	<0.01
COPPER (TOTAL)	mg/l	0.02	<0.01	<0.01	0.14
ZINC (TOTAL)	mg/l	0.05	0.03	0.04	0.10
MERCURY (TOTAL)	mg/l	<0.0002	<0.0002	<0.0002	0.0003
ARSENIC (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
LEAD (TOTAL)	mg/l	<0.05	<0.05	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.005	<0.005	<0.005	<0.005
pH (LAB)	pH units	5	5	5	5.20
SULFIDE	mg/l	<0.05	<0.05	<0.05	0.05
CYANIDE (TOTAL)	mg/l	0.844	0.546	0.450	0.163
CYANIDE (WAD)	mg/l	0.036	0.028	0.032	0.020

Test Description	Units	05	06
		CELL #6-#5 5- -10	CELL #6-#5 1- 0-15
BARIUM (TOTAL)	mg/l	0.87	0.98
CADMIUM (TOTAL)	mg/l	<0.005	<0.005
TRIVALENT CHROMIUM	mg/l	<0.01	<0.01
HEXAVALENT CHROMIUM	mg/l	<0.01	<0.01
COPPER (TOTAL)	mg/l	<0.01	<0.01
ZINC (TOTAL)	mg/l	0.03	0.03
MERCURY (TOTAL)	mg/l	0.0008	0.0016
ARSENIC (TOTAL)	mg/l	0.006	<0.005

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# TCLP Tests

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 3

Work Order # 91-12-035

Received: 12/05/91

12/20/91 11:35:41

Continued From Above

Test Description	Units	05	06
		CELL #6-#5 5- -10	CELL #6-#5 1- 0-15
LEAD (TOTAL)	mg/l	<0.05	<0.05
SELENIUM (TOTAL)	mg/l	<0.005	<0.005
pH (LAB)	pH units	5.14	5.10
SULFIDE	mg/l	0.13	0.09
CYANIDE (TOTAL)	mg/l	1.428	1.132
CYANIDE (WAD)	mg/l	0.152	0.214

B50

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 1

Work Order # 91-12-036

Received: 12/05/91

12/20/91 08:05:32

REPORT NEVADA GOLDFIELDS, INC.  
TO P.O. BOX 1530  
McCORMICK, SC 29835

PREPARED Davis & Floyd, Inc.  
BY P.O. Drawer 428  
Greenwood, S.C. 29648

ATTEN SCOTT WILKINSON

PHONE (803)-229\_5211

CERTIFIED BY

JOHN MCCORD

WORK ID JOB NO. 7623.00

P.O. #

TAKEN NEVADA GOLDFIELDS, INC.

TYPE SOLID

NUMBER OF SAMPLES 11

Comments:

WE ARE PLEASED TO PROVIDE THIS CERTIFIED REPORT OF ANALYSES.  
FEEL FREE TO TELEPHONE IF FURTHER EXPLANATION IS REQUIRED.  
UNLESS OTHER ARRANGEMENTS HAVE BEEN MADE, SAMPLES WILL BE  
DISPOSED OF OR RETURNED 28 DAYS FROM THE DATE OF THIS REPORT.

SAMPLE IDENTIFICATION

DATE COLLECTED

01 CELL #1-#3 0-5  
02 CELL #1-#3 5-10  
03 CELL #1-#3 10-15  
04 CELL #1-#3 15-20  
05 CELL #2-#3 0-5A  
06 CELL #2-#3 0-5B  
07 CELL #2-#3 5-10  
08 CELL #2-#3 10-15  
09 CELL #2-#3 15-20  
10 CELL #2-#3 20-25

Solid  
Ore  
Tests

DEC 23 1991  
RECEIVED

B51

# Total Ore Analysis (solid samples)

**Davis & Floyd, Inc.**

Laboratory Analysis Report

Page 2

Work Order # 91-12-036

Received: 12/05/91

12/20/91 08:05:32

Test Description	Units	01	02	03	04
		CELL #1-#3 0- -5	CELL #1-#3 5- -10	CELL #1-#3 1- 0-15	CELL #1-#3 1- 5-20
CADMIUM	mg/kg	3	3.6	3.5	3.3
COPPER	mg/kg	111	97	146	153
ZINC	mg/kg	25	21	29	21
SILVER	mg/kg	0.84	<0.60	0.66	0.86
MERCURY	mg/kg	<0.11	<0.11	<0.11	<0.11
ARSENIC	mg/kg	150	190	190	187
LEAD	mg/kg	150	132	274	216
CYANIDE (WAD)	mg/kg	<6	<6	<5.5	<5.7
CYANIDE (TOTAL)	mg/kg	30.9	24.3	34.7	21

Test Description	Units	05	06	07	08
		CELL #2-#3 0- -5A	CELL #2-#3 0- -5B	CELL #2-#3 5- -10	CELL #2-#3 1- 0-15
CADMIUM	mg/kg	5	3.1	3.8	3.3
COPPER	mg/kg	183	134	152	141
ZINC	mg/kg	27	26	26	27
SILVER	mg/kg	0.64	<0.58	0.63	<0.55
MERCURY	mg/kg	<0.10	<0.11	<0.11	<0.11
ARSENIC	mg/kg	296	129	204	176
LEAD	mg/kg	366	144	307	219
CYANIDE (WAD)	mg/kg	12.2	30.3	16.1	11
CYANIDE (TOTAL)	mg/kg	36.7	65.7	48.9	40.5

Test Description	Units	09	10
		CELL #2-#3 1- 5-20	CELL #2-#3 2- 0-25
CADMIUM	mg/kg	3	3.7

B52

# Total Ore Analysis (solid samples)

**Davis & Floyd, Inc.**

Laboratory Analysis Report

Page 3

Work Order # 91-12-036

Received: 12/05/91

12/20/91 08:05:32

Continued From Above

Test Description	Units	09	10
		CELL #2-#3 1- 5-20	CELL #2-#3 2- 0-25
COPPER	mg/kg	151	144
ZINC	mg/kg	37	33
SILVER	mg/kg	<0.55	0.61
MERCURY	mg/kg	0.11	<0.11
ARSENIC	mg/kg	149	219
LEAD	mg/kg	208	255
CYANIDE (WAD)	mg/kg	7.2	17.2
CYANIDE (TOTAL)	mg/kg	69.9	33.2

B53

## Solid Samples - Total Ore Analysis

Davis &amp; Floyd, Inc.

Laboratory Analysis Report

Page 2

Work Order # 91-12-038

Received: 12/05/91

12/20/91 08:09:29

Test Description	Units	01	02	03	04
		CELL #5-#4 0- -5	CELL #5-#4 5- -10	CELL #5-#4 1- 0-15	CELL #6-#5 0- -5
CADMIUM	mg/kg	3.6	2.6	2.4	7.9
COPPER	mg/kg	92	42	33	344
ZINC	mg/kg	19	20	13	24
SILVER	mg/kg	<0.59	<0.60	<0.64	1.40
MERCURY	mg/kg	<0.12	<0.12	<0.13	<0.12
ARSENIC	mg/kg	143	92	87	527
LEAD	mg/kg	120	130	98	377
CYANIDE (WAD)	mg/kg	<5.9	<6	<6.4	<6.1
CYANIDE (TOTAL)	mg/kg	38.5	34	38.2	32.9

Test Description	Units	05	06
		CELL #6-#5 5- -10	CELL #6-#5 1- 0-15
CADMIUM	mg/kg	4.1	4.2
COPPER	mg/kg	188	141
ZINC	mg/kg	22	25
SILVER	mg/kg	<0.61	1.06
MERCURY	mg/kg	<0.12	<0.12
ARSENIC	mg/kg	249	259
LEAD	mg/kg	285	392
CYANIDE (WAD)	mg/kg	<6.1	8.1
CYANIDE (TOTAL)	mg/kg	64.2	52.3

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**APPENDIX C**  
**GROUND WATER MONITORING PLAN**

FMC CORPORATION  
Research and Development Center  
Princeton, New Jersey

Report No. CPG/S/91-020  
September 12, 1991

**CYANIDE DETOXIFICATION OF GOLD MINE  
BARREN SOLUTIONS WITH HYDROGEN PEROXIDE**

Prepared For

Nevada Goldfields Inc.  
McCormick, SC

By  
Michael R. Fagan

**INTRODUCTION**

Laboratory experiments were conducted by FMC Corporation to determine the effectiveness of hydrogen peroxide ( $H_2O_2$ ) for destruction of cyanide ( $CN^-$ ) in a gold/silver mine process water (barren solution). In addition, the effect of  $H_2O_2$  treatment on dissolved metals was also monitored.

Results show that  $CN^-$  concentrations could be reduced from 225 mg/L to non-detectable levels in 6 hours using a  $H_2O_2:CN^-$  wt. ratio of 4:1 without addition of  $Cu^{++}$  catalyst. When 5 mg/L  $Cu^{++}$  catalyst was added,  $H_2O_2:CN^-$  wt. ratio's of 2.5:1 and 4:1  $H_2O_2:CN^-$  achieved non-detectable levels of  $CN^-$  in 5 and 3 hours respectively.

Hydrogen peroxide treatment also reduced the concentration of soluble metals (Cu, Zn, Cd, Ba) in this process water.

These studies should serve as a guide for field trials and/or commercial use.

## SUMMARY

A range of  $\text{CN}^-$  destruction rates were observed by varying the  $\text{H}_2\text{O}_2:\text{CN}^-$  wt. ratio's and copper catalyst concentrations. Cyanide destruction rates were enhanced by using 5 mg/L copper ion and/or higher ratio's of  $\text{H}_2\text{O}_2:\text{CN}^-$ .

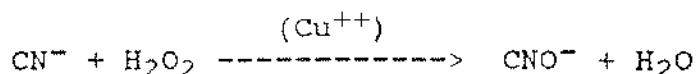
In experiment 1,  $\text{H}_2\text{O}_2:\text{CN}^-$  wt. ratio's of 1.5:1, 2.5:1 and 4:1 were tested without addition of  $\text{Cu}^{++}$  catalyst. The 4:1 wt. ratio achieved non-detectable  $\text{CN}^-$  levels after 6 hours. The 1.5:1 and 2.5:1 wt. ratio's reduced  $\text{CN}^-$  concentrations to 1 and 0.5 mg/L respectively in 24 hours (Table 1, Figure 1).

In experiment 2, the same wt. ratio's were used with 5 mg/L  $\text{Cu}^{++}$  catalyst (added as  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ). The addition of catalyst improved both the reaction rate and  $\text{H}_2\text{O}_2$  efficiency. This is evidenced by the fact that the 4:1  $\text{H}_2\text{O}_2:\text{CN}^-$  wt. reached non-detectable  $\text{CN}^-$  levels after 3 hours (compared to 6 hours w/o catalyst). Furthermore, the 2.5:1 ratio with  $\text{Cu}^{++}$  achieved non-detectable levels after 5 hours while the uncatalyzed version (experiment 1) required 24 hours to reduce  $\text{CN}^-$  levels to 0.5 mg/L.

The effect of  $\text{H}_2\text{O}_2$  treatment (without additional  $\text{Cu}^{++}$ ) on dissolved metal concentration was also measured in these experiments. When compared to an untreated control, The  $\text{H}_2\text{O}_2$  treated samples showed a decrease in the concentration of the following soluble metals: copper(63%), zinc(71%), cadmium(50%), and barium(20%). The concentrations of arsenic, lead, mercury, selenium, and chromium were essentially unchanged (see attached analysis sheet).

## DISCUSSION

The use of  $\text{H}_2\text{O}_2$  for the detoxification of simple and weakly complexed cyanides is well known. Hydrogen peroxide will oxidize cyanide with or without catalysts. The reaction rate is improved however, by small amounts of soluble copper, either naturally occurring or when added as  $\text{CuSO}_4$  or  $\text{Cu}(\text{NO}_3)_2$ . The reaction can be written as follows:



The product of this reaction,  $\text{CNO}^-$  (cyanate), is 1,000 times less toxic than cyanide. At a pH of 7, cyanate hydrolyzes to form carbon dioxide and ammonia. The reaction rate is dependent on the concentration of  $\text{H}_2\text{O}_2$  and the amount of copper present. While the



stoichiometric wt. ratio of  $H_2O_2$  to  $CN^-$  needed to convert  $CN^-$  to  $CNO^-$  is 1.3:1, in practice a higher ratio is usually employed. The higher ratio speeds up the reaction and compensates for the loss of  $H_2O_2$  to  $O_2$  and  $H_2O$  due to decomposition by metals and alkaline pH conditions. The experimental findings are in keeping with what is known about  $H_2O_2$  and  $CN^-$  reactions.

The reduction in soluble metals concentration (Cu, Zn, Cd, and Ba) is likely the result of  $H_2O_2$  oxidation of these metals to a less soluble oxidation state. This was noted in the formation of a small amount of precipitate in the  $H_2O_2$  treated samples.

The results will be found in Tables 1 & 2, Figures 1 & 2, and the attached analysis sheet.

## EXPERIMENTAL

### Barren Solution Sample

An essentially clear barren solution sample with a pH of 11.5 and a  $CN^-$  concentration of 225 mg/L was received at FMC's Princeton R&D facility from Nevada Goldfields Inc. McCormick, South Carolina. All tests were run under ambient temperature conditions (25°C). No pH adjustment or filtration of the samples were done prior to treatment.

### Treatment

Barren solution samples (250 mls) were charged with targeted amounts of 50% Standard Grade  $H_2O_2$  and stirred for 30 seconds to ensure a homogeneous solution. After this time, the samples were allowed to react without agitation. In the case of the  $Cu^{++}$  catalyzed treatments, the copper was dissolved in the sample prior to addition of  $H_2O_2$ . The reaction was allowed to proceed until the  $H_2O_2$  was exhausted and/or cyanide levels were below detectable limits.

### Analyses

Cyanide concentrations were determined over the course of these experiments using the Buffered Picric Acid procedure. The principle behind this analysis is the reaction of cyanide with the picric acid reagent to produce an orange color which can be measured spectrophotometrically at 520 nm. This method measures both "free" and WAD (weakly acid dissociable) cyanides. The detection limit for this procedure is 0.26 mg/L.

Metals analysis were performed by the following techniques:

As, Pb, Cd, Se, Cr

- GFAAS (Graphite Furnace Atomic Absorption Spectroscopy)

Cu, Ba

- ICP (Inductively Coupled Plasma)

Hg

- HYDAAS (Hydride Atomic Absorption Spectroscopy)

Zn

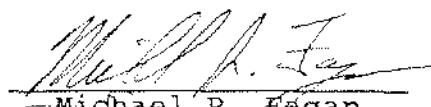
- FAAS (Flame Atomic Absorption Spectroscopy)

### CONCLUSIONS

Based on laboratory studies conducted by FMC Corporation for Nevada Goldfields Inc. The following conclusions/recommendations are given regarding the use of hydrogen peroxide for cyanide detoxification of this gold/silver mine effluent.

- 1) Hydrogen peroxide can effectively destroy cyanide in this mine effluent to non-detectable levels (i.e. <0.26 mg/l) when  $H_2O_2:CN^-$  wt. ratio's of between 2.5:1 and 4:1 are used. It is recommended that a trial be conducted to confirm these results under actual field conditions.
- 2) Hydrogen peroxide treatment resulted in decreased levels of the following soluble metals: Cu, Zn, Cd, and Ba when compared to the untreated control. The levels of As, Pb, Hg, Se, and Cr were essentially unchanged. The use of a flocculating or metals precipitating product should be considered to further reduce soluble metal concentrations.
- 3) To provide uniform distribution of  $H_2O_2$  during field scale treatment, a mix tank of appropriate size (e.g., 1000 gal.) should be used to introduce the  $H_2O_2$  into the barren solution.
- 4) The  $H_2O_2/CN^-$  reaction rate can be enhanced by the addition of 5 mg/L  $Cu^{++}$  to the barren solution.

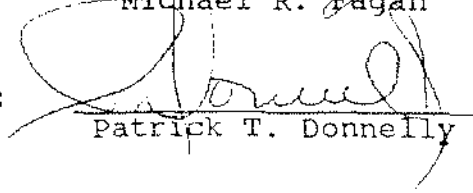
Prepared by:

  
Michael R. Fagan

Date:

9/12/91

Approved by:

  
Patrick T. Donnelly

Date:

9-12-91

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FMC CORPORATION  
Research and Development Center  
Princeton, New Jersey

CPG/S/91-202  
Page 5

REFERENCES

1. FMC Technical Bulletin #130 - "Cyanide Treatment with Peroxygen Compounds"
2. "The Direct Spectrophotometric Determination of Cyanide with Picric Acid Reagent" - P. Tamarino, June 1989
3. FMC Corporation, Research Record #E-6851

TABLE 1

NEVADA GOLD FIELDS INC.

## Data Table - Experiment 1

Time (Hr)	<u>CN- Concentration Over Time</u>		
	<u>1.5:1 Ratio</u> <u>(H2O2:CN-)</u>	<u>2.5:1 Ratio</u> <u>(H2O2:CN-)</u>	<u>4:1 Ratio</u> <u>(H2O2:CN-)</u>
0	225 mg/L	225 mg/L	225 mg/L
1	205 "	175 "	135 "
3	165 "	100 "	28 "
4	140 "	72 "	8 "
5	120 "	40 "	1 "
6	112 "	35 "	ND "
24	1 "	0.5 "	-

ND = Non-detectable (measured by buffered picric acid procedure)

TABLE 1

NEVADA GOLD FIELDS INC.

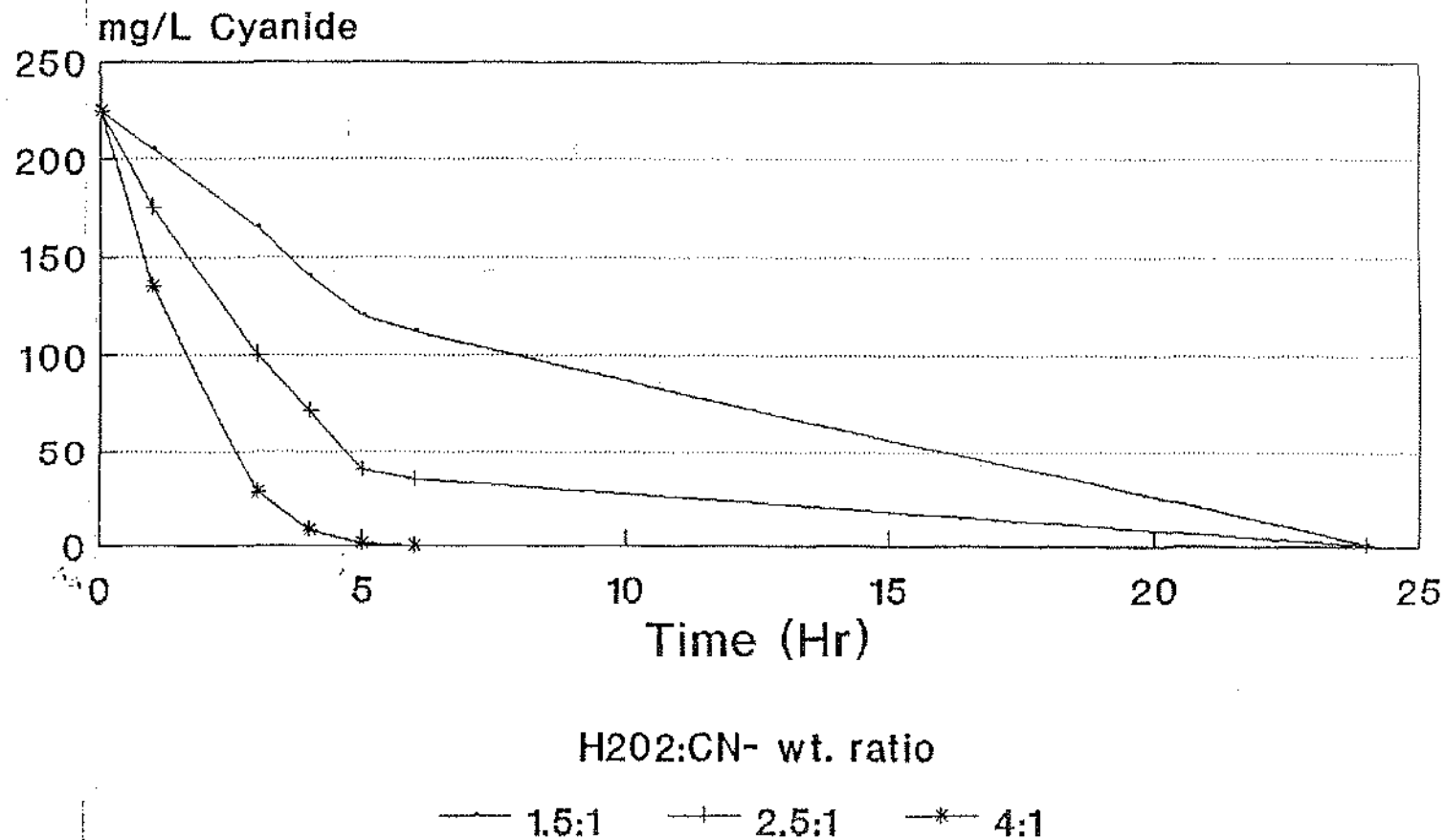
## Data Table - Experiment 1

Time (Hr)	<u>CN- Concentration Over Time</u>		
	<u>1.5:1 Ratio</u> <u>(H2O2:CN-)</u>	<u>2.5:1 Ratio</u> <u>(H2O2:CN-)</u>	<u>4:1 Ratio</u> <u>(H2O2:CN-)</u>
0	225 mg/L	225 mg/L	225 mg/L
1	205 "	175 "	135 "
3	165 "	100 "	28 "
4	140 "	72 "	8 "
5	120 "	40 "	1 "
6	112 "	35 "	ND "
24	1 "	0.5 "	-

ND = Non-detectable (measured by buffered picric acid procedure)

FIGURE 1

# Nevada Goldfields Inc. Cyanide Detoxification



Prepared by MR Fagan - FMC Corp.

TABLE 2

NEVADA GOLD FIELDS INC.

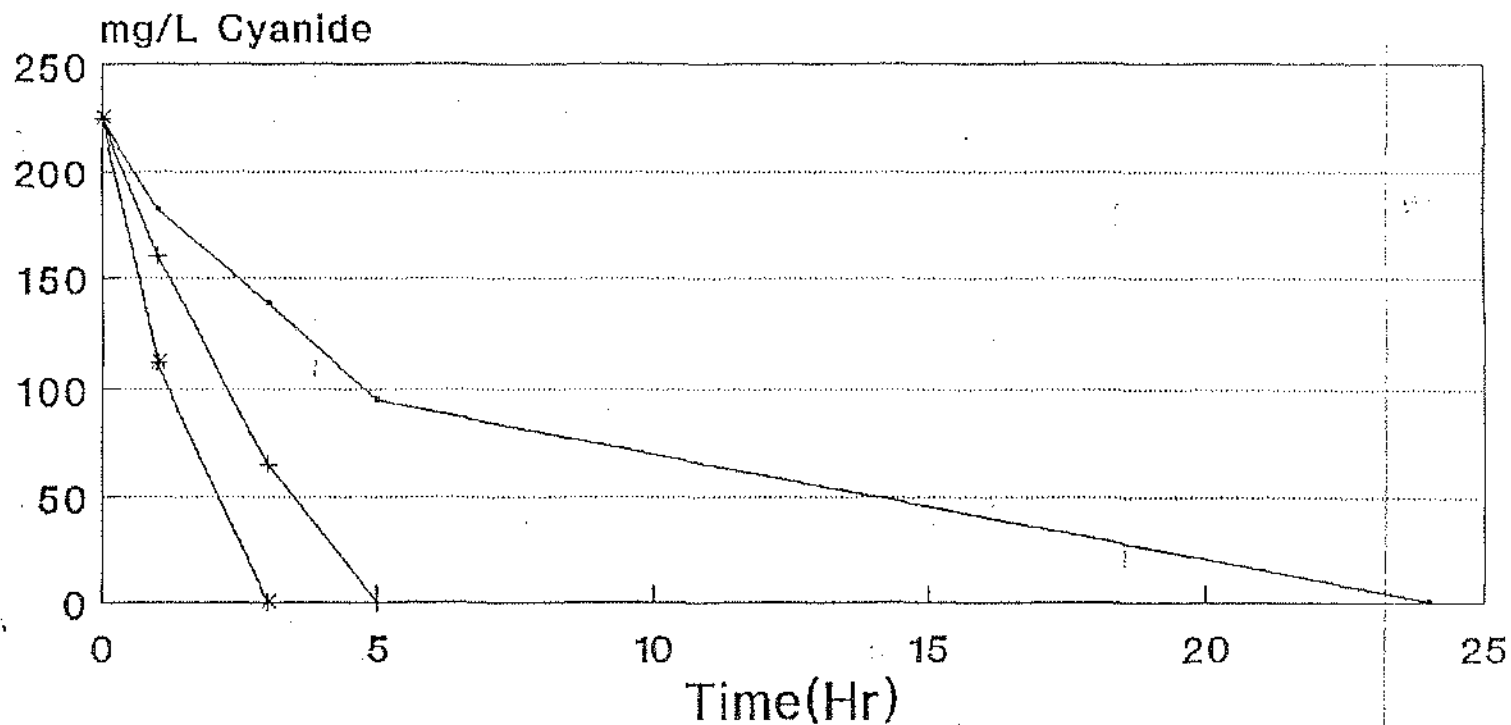
Data Table - Experiment 2  
(5 ppm  $\text{Cu}^{++}$  catalyst added to all 3 Treatments)

Time (Hr)	<u>CN<sup>-</sup> Concentration Over Time</u>		
	<u>1.5:1 Ratio</u> <u>(H<sub>2</sub>O<sub>2</sub>:CN<sup>-</sup>)</u>	<u>2.5:1 Ratio</u> <u>(H<sub>2</sub>O<sub>2</sub>:CN<sup>-</sup>)</u>	<u>4:1 Ratio</u> <u>(H<sub>2</sub>O<sub>2</sub>:CN<sup>-</sup>)</u>
0	225 mg/L	225 mg/L	225 mg/L
1	182 "	160 "	112 "
3	138 "	65 "	ND
5	95 "	ND	-
24	0.5 "	-	-

ND = Non-detectable (measured by buffered picric  
acid procedure)

FIGURE 2

# Nevada Goldfields - Cyanide Detox. H<sub>2</sub>O<sub>2</sub> with Cu<sup>++</sup> Catalyst



H<sub>2</sub>O<sub>2</sub>:CN<sup>-</sup> Wt. Ratio

— 1.5:1 (5 ppm Cu<sup>++</sup>)

—+— 2.5:1 (5 ppm Cu<sup>++</sup>)

—\*— 4:1 (5 ppm Cu<sup>++</sup>)

Prepared by MR Fagan-FMC Corp.

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**REQUEST FOR ANALYSIS AND RECORD OF RESULTS**  
(Submit White and Pink Copies)

**Safety Check List**  
HAZARD INFORMATION CHECK

<b>HEALTH HAZARD</b> 4 — Deadly 3 — Extreme danger 2 — Hazardous 1 — Slightly hazardous 0 — Normal material	<b>FIRE HAZARD</b> Flash Points 4 — Below 73°F 3 — Below 100°F 2 — Below 200°F 1 — Above 200°F 0 — Will not burn
<b>SPECIFIC HAZARD</b> Oxidizer Acid Alkali Corrosive Use NO WATER Radiation Hazard Carcinogen	<b>REACTIVITY</b> 4 — May detonate 3 — Shock and heat may detonate 2 — Violent chemical change 1 — Unstable if heated 0 — Stable

**Physical Properties**  
Soluble in \_\_\_\_\_  
M.P. or B.P. \_\_\_\_\_

Highly Volatile ☐ **Sample Disposal Method**  
Hygroscopic ☐ Return to Requestor ☐  
Discard ☒ Waste Class \_\_\_\_\_

Using Dept. \* \_\_\_\_\_ Project \_\_\_\_\_ Sub. Proj. \_\_\_\_\_  
Charge No. H020 4824 000

\*ICG use Group/Chemical Numbers

Requested By M. R. Fagan Date 3/4/91  
Location IC-30 Tel. Ext. 4161  
Sample Designation MINE WATER — Treated (1)  
Sample Description MINE WATER — Untreated (1)

Requested Analyses/Special Instructions Filter Precipitates before analysis for metals  
PLEASE ANALYZE FOR: ARSENIC, LEAD, COPPER, MANGANESE, ZINC, CADMIUM, SELENIUM, BARIUM, CHROMIUM  
Estimated Cost \_\_\_\_\_ Estimated By \_\_\_\_\_ Approved By \_\_\_\_\_ Date \_\_\_\_\_

(Analytical Use Only)

Results:

	<u>Treated</u>	<u>Untreated</u>	<u>METHOD:</u>
(ppm) As —	<0.05	<0.05	GFAAS
(ppm) Pb —	<0.05	<0.05	"
(ppm) Cu —	2.3	6.2	ICP
(ppm) Hg —	<0.05	<0.05	HYDAAS
(ppm) Zn —	<0.2	0.7	FLAME AAS
(ppm) Cd —	<0.05	0.10	GFAAS
(ppm) Se —	0.19	0.22	GFAAS
(ppm) Ba —	0.63	0.79	ICP
(ppm) Cr —	0.23	0.22	GFAAS

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Work done by:

Center Technical Dept. ☐ Industrial Chemical Group ☒ Agricultural Chemical Group ☐  
Analyst D.S. N.S. Ref. E315/A Approved \_\_\_\_\_ Date 9/9/91

Log. No. \_\_\_\_\_

NEVADA GOLDFIELDS INC.  
BARITE HILL PROJECT

GROUND WATER MONITORING PLAN

SOLID WASTE DUMP  
PERMIT IWP-242

NEVADA GOLDFIELDS  
GROUND WATER MONITORING PLAN  
SOLID WASTE DUMP  
PERMIT IWP - 242

In accordance with solid waste permit IWP - 242, the following ground water monitoring plan is submitted for our residue disposal facility.

GROUND WATER MONITORING SYSTEM

Seven clusters of monitoring wells have been installed for the facility. Each cluster consists of one shallow well to monitor saprolite water table as requested in permit condition 7, and also wells to monitor any deeper fracture zones that are hydraulically active. These well locations are shown on the enclosed drawing (IWF-1). A schematic drawing of both the shallow and deep wells is also enclosed. The well depths are as follows:

WELL NUMBER	DEPTH	WELL NUMBER	DEPTH
A1	193 FT	B1	171 FT
A2	143 FT	B2	121 FT
A3	70 FT		
C1	182 FT	D1	130 FT
C2	75 FT	D2	160 FT
GW-5	37.8 FT	D3	79 FT
E1	60 FT	F1	205 FT
E2	300 FT	F2	140 FT
E3	106 FT	F3	75 FT
GW-6	28.4 FT		
G1	38 FT		
G2	200 FT		
G3	125 FT		

Two systems (clusters A and F) have been installed hydraulically upgradient from the facility for groundwater samples that are representative of background groundwater quality and are not affected by the facility.

Five systems (clusters B, C, D, E, and G) have been installed hydraulically downgradient from the facility to detect any statistically significant degradation of groundwater quality if degradation of groundwater were to occur. In addition, four more wells have been installed hydraulically downgradient from the waste facility toe, one on either side of Well cluster D and two around

the edges of the Barren Pond, as shown on the enclosed drawing. These four wells (L, M, O, and P) will monitor water quality in the uppermost aquifer.

The monitoring system will be maintained so that water quality immediately upgradient and downgradient of the facility may be measured.

All monitoring wells have been or will be constructed and integrity will be maintained in accordance with R.61-71.

If it is determined by Nevada Goldfields or SCDHEC that the groundwater monitoring system no longer satisfies the minimum requirements for the number, location, construction, or integrity of the wells with relation to structurally damaged wells, dry wells, wells no longer upgradient or downgradient, etc., Nevada Goldfields will:

1. Notify SCDHEC Solid and Hazardous waste Div. in writing within seven days of evaluation data, but no later than sixty days after collecting water level data, that the monitoring system no longer satisfies permit conditions;
2. Submit to SCDHEC Solid and Hazardous Waste Div. in writing a complete proposal to upgrade the monitoring well network within thirty days of notification from DHEC, but no later than ninety days after collecting water level data; and
3. Complete installation of additional well(s) necessary to achieve compliance with permit conditions within forty-five days of receiving approval from DHEC.

#### ROUTINE GROUNDWATER MONITORING

Nevada Goldfields will perform routine monitoring of groundwater quality and elevation conditions to determine if residue disposal activities are affecting groundwater quality at the facility.

Groundwater monitoring will be performed according to the constituent list and schedule in table 1 for all wells specified in the permit condition 7d and any other well(s) deemed necessary by the facility or SCDHEC. A copy of the sampling and analysis plan used by Nevada Goldfields is enclosed.

Initially, only the wells to the upper aquifer will be sampled. These wells will be sampled twice within one week and then quarterly during the first year of operation for background data. They will continue to be sampled quarterly throughout the life of the project and after closure. If, at any time, it appears that the upper aquifer is becoming contaminated by metals or cyanide leaching from the residues, then the monitor wells to the second

aquifer will be sampled twice in one week to start establishing background data for this aquifer.

Nevada Goldfields will determine on a quarterly basis the elevation of the groundwater surface in each sampled well the same day the samples are collected.

Each quarter, Nevada Goldfields will collect, preserve and analyze groundwater samples as outlined in the enclosed Sampling and Analysis Plan, for the constituents listed in table 1. The following procedures will also be used:

Samples will be collected by bailing using E.P.A. protocols. Three well volumes will be evacuated prior to collection of the sample, or the well will be evacuated until dry. Well volumes will be determined by measuring the depth to water - depth to bottom of well \* radius of the well squared \* pi.

Samples will be preserved according to E.P.A. protocols. These protocols are outlined in the Appendix to the attached Sampling and Analysis Plan.

Samples will be sent to a SCDHEC certified lab for analysis on all constituents listed in table 1.

#### DATA EVALUATION

It is well known that the metals and other constituents of groundwater vary greatly throughout the course of the year. Rainfall events and changes in the height of the water table can naturally cause wide fluctuations in the measured parameters. This needs to be taken into account when evaluating groundwater data.

Another factor that needs to be taken into account is the general mineralization of the area. Nevada Goldfields, Inc. would not be mining here if significant mineralization had not occurred in this area. This means that many metal values may naturally be outside of "normal" groundwater parameters. No amount of remediation will change "natural" metal levels to "normal" ones.

Nevada Goldfields will establish baseline water quality data for all wells for the constituents included in the first six sampling events as specified in table 1. The six sampling events will include two events prior to waste disposal to be collected at a time interval not less than one week apart, and four quarterly sampling events during the first year of operation.

Nevada Goldfields will compare the downgradient water quality to the upgradient water quality using one or more of the procedures specified in the Federal Register, 40 CFR Parts 257 and 258.

The initial six samples of each downgradient well and the results of the two upgradient wells (18 samples total) will be used as the sample population to establish a tolerance interval for each constituent using the distribution of the background data.

A tolerance interval represents the limits within which a specified percentage of the population is expected to lie with a given probability. If the standard deviation of the population of samples were known, the limits for a given percentage of the population could be calculated with certainty. However, when only an estimate of the standard deviation is known, based on a limited sampling population, a tolerance interval based on inclusion of a percentage of the population with a specific probability of inclusion is all that can be calculated.<sup>1</sup>

The tolerance interval will be calculated as follows:

$$\text{Tolerance Interval} = \bar{X} \pm ks$$

where  $\bar{X}$  is the sampled population mean,  $s$  is the estimated standard deviation, and  $k$  is a factor based on the percentage,  $p$ , of population to be included, the probability,  $t$ , of inclusion, and the number of measurements used to calculate  $\bar{X}$  and  $s$ . The percentage and probability will both be used at the 95% level, corresponding with the .05 Type I error level suggested in the EPA subtitle D regulations. The  $k$  value will be taken from a chart such as that found in NBS Handbook 91.<sup>2</sup> For the purpose of determining  $\bar{X}$  and  $s$ , all data reading below the detection limit will be used as the detection limit value.

After the tolerance interval has been established, any sample that reads outside of the interval will be suspected of showing groundwater contamination for the element in question.

There will be some parameters that can not be analyzed by the above method. Any samples that constantly read below the detection limit will have no measurable standard deviation, and therefore no tolerance level. An increase in the reported values of these samples over three sampling events will be considered to show possible contamination.

If groundwater contamination is suspected, the well will be resampled and reanalyzed for the suspicious parameters. If

---

<sup>1</sup> Taylor, John; Quality Assurance of Chemical Measurements, Lewis Publishers, c1987, pg31.

<sup>2</sup> Natrella, M.G., "Experimental Statistics", NBS Handbook 91, National Bureau of Standards, Gaithersburg, MD 20899.

the second sampling also shows values outside the allowable range, the Department will be notified. If the average of the two values is greater than groundwater limits for the parameter, an assessment of groundwater impact will begin as addressed in Permit IWP-242, Condition 10. If the average of the two values is less than groundwater limits, no action will be taken until after sampling is completed for the following quarter.

The following quarter the monitor well in question would be sampled along with the rest of the wells. If the value of the suspicious parameter shows an increase when compared with the average value obtained from the two samples taken the previous quarter, the well will be resampled and retested for that parameter. If the average of these two values is higher than the average from the previous quarter, assessment of groundwater impact will begin. If the value of the suspicious parameter has decreased when compared with the average value obtained from the two samples taken the past quarter, we will wait and see what the following quarter's results are for that parameter.

This quarterly tracking will continue until the parameter has dropped back to within the allowable range (at which time the incident is assumed to be over), the average value of the two samples taken within the same quarter has increased for two consecutive quarters, or the value has increased above groundwater limits.

The quarterly samples from the upgradient wells will be compared with the baseline established from these wells (12 samples) in the same manner. This will help to determine if the groundwater is deteriorating above the minesite. If these wells show groundwater deterioration, the Department will be notified so that it may look for the cause if it deems it is warranted.

If any more wells are added to the system due to changing hydrology, etc., the same plan will be used.

Nevada Goldfields will ensure that the groundwater flow rate and direction are evaluated by a qualified registered professional geologist or geotechnical engineer each time samples are taken. A potentiometric surface map will be generated which will demonstrate the flow directions for the uppermost aquifer.

#### CLOSURE/POST CLOSURE MONITORING

Nevada Goldfields will monitor groundwater quality in the upgradient and downgradient wells in the uppermost aquifer at the facility for a period of thirty years as required in permit condition 12. After five years of post closure monitoring, NGI

will petition DHEC to terminate or modify post closure monitoring if study of the site hydrology and groundwater quality shows justification.

The monitoring program will be identical to the operations monitoring plan described in detail above. The cost of the groundwater monitoring program is projected at \$30,000 per year (in constant 1991 dollars).

#### REPORTING

Nevada Goldfields will submit results of the groundwater monitoring program as specified in table 1 in accordance with the following schedule stipulated in permit condition 13:

<u>Sampling Quarter</u>	<u>Sampling Period</u>	<u>Results to DHEC</u>
1st	January-February	April 15
2nd	April-May	July 15
3rd	July-August	October 15
4th	October-November	January 15

Nevada Goldfields will submit a quarterly report containing all water quality data and statistical analyses to DHEC as specified in the schedule above. An annual report will be submitted with the fourth quarter report summarizing the quarterly determinations of groundwater flow direction and rate. This report will include determination as to whether the monitoring well network continues to meet the requirements of permit condition 7.



GROUND WATER MONITORING WELLS  
SAMPLING AND ANALYSIS PLAN

## INTRODUCTION

Monitoring of the ground water is an important part of the overall plan to protect the environment at the Barite Hill Project. Ground water monitor wells have been strategically placed so that any leaks in the solid waste facility, the pads, or ponds can be detected and the problem addressed before irreparable damage is done to the environment. Two well clusters, A and F, have been installed upgradient of the system. These wells will be used to determine the background quality of the ground water. The rest of the wells are hydraulically downgradient.

This sampling plan must be followed to ensure that the ground water samples taken are truly representative of the ground water, that no contamination is introduced into the ground water by the sampling procedures, and that the analytical results are accurate.

## EQUIPMENT/SITE PREPARATION

1. All wells are to be kept locked unless sampling is taking place.
2. Equipment used for monitor well sampling is dedicated for this purpose only and is stored in such a way as to keep it clean and free of contamination.
3. All equipment that will go down the well (M-scope, teflon bailer) are triple rinsed with distilled water and allowed to dry before entering each well.

## CALCULATION OF AMOUNT OF WATER TO BE EVACUATED PRIOR TO SAMPLING

4. Depth to water is to be measured from the top of the PVC casing using the M-scope. Depth to water is measured in all wells that are to be sampled before sampling any of the wells. Depth to water is recorded on Water Sampling Form (See Appendix).
5. Subtract the depth to water from the total depth of the well to calculate the length of the water column.
6. Use the following formula to find the total volume of water in the well:  
$$\text{Volume} = (0.5 \times \text{casing diameter})^2 * \pi * \text{water column depth}$$
7. Multiply the volume obtained in step six above by 3 to get the amount of water that must be evacuated before sampling.

### PUMPING WELLS AND SAMPLE COLLECTION

8. Sample upgradient wells first to ensure they are not contaminated by anything in the downgradient wells.

FOR 4" diameter wells with dedicated air-lift pumps (GW 1,2,3,5&6)

9. Pump the well with the dedicated air lift pump into a graduated bucket until the three well volumes calculated in step seven are evacuated or until the well is pumped dry.
10. Allow the well to recover enough volume to fill the required sample bottles, then sample while wearing latex gloves. The required parameters to sample for are listed in the Appendix.

FOR 2" Monitor Wells (no pumps, Wells A-O)

11. Lay plastic on the ground around the well to prevent contamination of the sampling equipment. Wear latex gloves to prevent contaminating the bailer with your hands. Evacuate three well volumes (calculated in step 7) or until dry, using the teflon bailer and disposable bailing line. Disposable bailing line should be composed of a chemically inert material such as polypropylene rope or nylon weedeater line. (Be sure to replace bailing line before bailing each well.)
12. Fill the required sample bottles using the teflon bailer. The required parameters are listed in the Appendix.

### QUALITY CONTROL SAMPLES

13. Each sampling event should include double sampling one well for all parameters. These samples will be sent in to the lab for analysis under the designation Well T. Randomly pick which well is to be sampled by drawing from a hat. Record which well is picked on the Water Sampling Form. Sample as above. Blank samples consisting of distilled water will also be sent to the laboratory under the designation Well U.

### INTERIM SAMPLE STORAGE

14. Immediately after collecting each sample, add any preservatives necessary, (see Table 1), cap and store in cooler. Sample bottles usually already contain the preservatives necessary when sent from the lab, however, you should check the label to make sure no mistakes were made and the preservative in the bottle is the correct one.

## FIELD MEASUREMENTS

15. pH, Specific Conductivity, and Temperature measurements must be taken in the field.

pH - Calibrate meter using the two standard method. First, place the electrode in pH 7.00 buffer solution and set meter to 7.00 using the calibration knob. Rinse the electrode by swirling in distilled water and then place in the pH 4.00 buffer solution. Adjust the slope so the meter reads 4.00. Field calibration should be done in the field so the temperature at calibration is as close as possible to the temperature at reading. (The meter has built-in temperature compensation, but will still fluctuate slightly with temperature.) Again rinse electrode with distilled water. Repeat the above steps until stable readings are obtained. The meter is now ready to operate. Read ground water field pH by placing electrode into a sample. The pH recorded will be the average of three separate readings taken at each well. Check for meter drift by reading the pH of the pH 4.00 buffer at least every fourth well. Recalibrate meter if needed.

Specific Conductivity - Specific conductivity is also read in the field using a meter. The probe calibration is checked by reading a standard solution of a known conductivity. If this reading is not correct, follow the manufacturer's instructions to recalibrate the probe. Again, the specific conductance recorded will be an average of three separate conductivity readings for each well.

Temperature - Temperature is read of a thermometer allowed to equilibrate in a ground water sample.

## CHAIN OF CUSTODY

16. A Chain of Custody must be kept with all monitor well samples to ensure that the sample taken from the well is the same sample that reaches the lab for analysis. The sampler should fill out a Chain of Custody form for all samples. An example of a Chain of Custody form can be found in the Appendix. A copy of the completed Chain of Custody forms and copies of the completed water sampling forms should be turned into Jean Whisnant.

## SHIPMENT

17. Samples will be preserved at 4 degrees C immediately after collection (See Interim Storage Section above). They will

continue to be held at 4°C until delivery to the lab for analysis. Sample coolers will either be sealed and shipped overnight or hand delivered to the lab. The limited holding time is 48 hours for nitrate samples, so samples must be received by the lab in time to do these analyses.

## APPENDIX

DATE   /  /  

WELL ID#\_\_\_\_\_

DUPLICATE ID# \_\_\_\_\_

END

TIME OF SAMPLING:

TD:

DTW: \_\_\_\_\_

**COLUMN:** \_\_\_\_\_

VOL/FT: \_\_\_\_\_

VOL/WELL: \_\_\_\_\_ X3 =VOL. EVACUATED

**LAB**

☐ ON-SITE

## CONTAINERS

**PRESERVATIVE**

pH \_\_\_\_\_  
SP. COND. \_\_\_\_\_

REMARKS:

**SAMPLERS:**

C25

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL  
SOLID WASTE LANDFILL GROUNDWATER DETECTION MONITORING REQUIREMENTS  
(12/89)

Constituent	*2 Samples Prior To Waste Disposal	*1st Year Quarterly	Second Year and All Remaining Years	
			1st, 2nd & 3rd Qtr	4th Qtr
Ammonia	X	X		X
Bicarbonate	X	X		X
Calcium	X	X		X
Chloride	X	X	X	X
Fluoride	X	X		X
Iron	X	X	X	X
Magnesium	X	X		X
Manganese	X	X		X
Nitrate (as N)	X	X	X	X
Potassium	X	X		X
Sodium	X	X		X
Sulfate	X	X	X	X
TOC	X	X	X	X
Total Dissolved Solids	X	X	X	X
Temperature	X	X	X	X
Specific Cond.	X	X	X	X
pH (Field & Lab)	X	X	X	X
Aluminum	X	X	X	X
Arsenic	X	X	X	X
Barium	X	X	X	X
Cadmium	X	X	X	X
Chromium	X	X	X	X
Copper	X	X	X	X
Lead	X	X	X	X
Nickel	X	X	X	X
Mercury	X	X	X	X
Selenium	X	X	X	X
Silver	X	X	X	X
Zinc	X	X	X	X
Cyanide	X	X	X	X
Water Level Elev. All Wells (Feet MSL)	X	X	X	X

\* Applies only to New or Expanding Facilities



**U.S. EPA RECOMMENDED PRESERVATION  
METHODS FOR WATER AND WASTEWATER SAMPLES<sup>a</sup>**

Test	Preservation Method	Max. Recommended Holding Time
Acidity Alkalinity	Store at 4°C	14 days
Ammonia	Add H <sub>2</sub> SO <sub>4</sub> to pH <2 Store at 4°C	24 hours
BOD	Store at 4°C	48 hours
COD	Add H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days
Chloride	None required	28 days
Chlorine, residual	Det. on site	No holding
Cyanide	Add NaOH to pH >12 Store at 4°C	14 days
Dissolved Oxygen	Det. on site	No holding
Fluoride	None required	28 days
Mercury	Add HNO <sub>3</sub> to pH <2	28 days (in glass) 13 days (in plastic)
Metals	Add HNO <sub>3</sub> to pH <2	6 months
Nitrate	Add H <sub>2</sub> SO <sub>4</sub> to pH <2 Store at 4°C	48 hours
Nitrite	Store at 4°C	48 hours
Oil & Grease	Add H <sub>2</sub> SO <sub>4</sub> to pH <2	28 days
Organic Carbon	Add H <sub>2</sub> SO <sub>4</sub> to pH <2 Store at 4°C	28 days
pH	Store at 4°C	No holding
Phenolics	Add H <sub>3</sub> PO <sub>4</sub> to pH <4 & 1.0 g CuSO <sub>4</sub> /L Store at 4°C	28 days
Phosphorus, ortho	Filter on site	48 hours
Phosphorus, total	Add H <sub>2</sub> SO <sub>4</sub> to pH <2 Store at 4°C	28 days
Solids	Store at 4°C	7 days
Specific Conductivity	Store at 4°C	28 days
Sulfate	Store at 4°C	28 days
Sulfide	Add 2ml 1 M zinc acetate & 1 N NaOH to pH >9 Store at 4°C	7 days
Temperature	Det. on site	No holding
T. Kjeldahl Nitrogen	Add H <sub>2</sub> SO <sub>4</sub> to pH <2 Store at 4°C	28 days
Turbidity	Store at 4°C	48 hours

<sup>a</sup> FEDERAL REGISTER, Vol. 49, No. 209, Friday, October 26, 1984.

[illegible]

**APPENDIX D**

**RECLAMATION PLAN FORM MR-500**

RECLAMATION PLAN

Permit # \_\_\_\_\_

1. What useful purpose(s) will the affected land be reclaimed to (check one or more)?

a. lake or pond _____	f. grassland <u>  x  </u>
b. agriculture _____	g. recreation _____
c. woodlands _____	h. marsh land _____
d. residential _____	i. park _____
e. commercial _____	j. other _____

2. Describe practices to protect adjacent resources such as streams, roads, wildlife areas, woodland, cropland and others during mining and reclamation. Please see the following sections in the attached "Description of Mine Activities Report",

a. Section 5.4, Sediment Control Structures;  
 b. Section 6.4, Pad Leak Detection System;  
 c. Section 6.6, Solution Ponds;  
 d. Section 7.0, Mine Waste Disposal Areas;  
 e. Section 8.0, Operation and Monitoring; and  
 f. Section 9.0, Reclamation.

3. Surface Gradient Restoration

- (a) What will be the final maximum surface gradient in soil, sand, or other unconsolidated materials on the reclaimed lands? (slopes steeper than 3H:1V must have prior approval by the Department)

3H: 1V

- (b) Proposed method for accomplishing surface gradient:

Please see the following section in the attached "Description of Mine Activities R

a. Section 9.1, Surface Grading and Restoration

Describe the plan for revegetation or other surface treatment of affected area(s).

Please see the following section in the attached "Description of Mine Activities Report"

a. Section 9.4, Revegetation

DI

Permit # \_\_\_\_\_

5. Method of prevention or elimination of conditions that will be hazardous to animal or fish life in or adjacent to the area (include safety, pollution, sediment and/or other measures). The mine location is remote. No adverse effect is anticipated on animal and fish life or on any publicly or privately owned lands. Additionally, present U.S. Forest Service lands, adjacent to proposed mine lands, shall become the property of applicant before mining activities commence. Nearby Lake Thurmond is a recreational lake and shall be protected from any mine pollutants from applicant's compliance with a NPDES permit.

6. Method of rehabilitation of settling pond.

Please see the following section in the attached "Description of Mine Activities Report,"  
a. Section 9.0, Reclamation

7. Method of control of contaminants and disposal of mine refuse. Please see the following sections in the attached "Description of Mine Activities Report",

- a. Section 6.0, Heap Leach Facility Design;
- b. Section 7.0, Mine Waste Disposal Areas; and
- c. Section 8.0, Operation and Monitoring

8. Method of restoration or establishment of stream channels and stream banks to a condition-minimizing erosion, siltation and other pollution.

Not Applicable; deterioration of stream channels or banks is not anticipated.

9. Method of controlling erosion and off-site siltation from temporary spoil banks and ridges. Please see the following sections in the attached "Description of Mine Activities Report",

- a. Section 5.4, Sediment Control Structures;
- b. Section 7.0, Mine Waste Disposal Areas;
- c. Section 8.0, Operation and Monitoring; and
- d. Section 9.0, Reclamation.

10. What are your plans for maintenance to insure that the reclamation practices established on the affected land will not deteriorate before released by the Department? Regular inspections of the reclamation practices established and monitoring of their performance shall be conducted. In the event that practices are deteriorated before they are released by the Department, the applicant shall ensure prompt repair or re-establishment of such practices, within a reasonable period of time.

Outline provisions of reclamation for safety to persons and to adjoining property in all excavation of rock. (Include such provisions as setbacks, fencing, signs, benches, boulders, etc.)

The mine location is remote. There are no potential physical hazards to persons or neighboring dwellings for they are beyond a one-half mile radius from mine activities. Appropriate setbacks, fences, signs, and roadways shall be established to protect on-site personnel.

What provisions will be taken to prevent noxious, odious, or foul pools of water from collecting and remaining on the mined area?

During all mining activities, the applicant shall ensure that collected pools of water within the mine areas shall be disposed of promptly and properly to avoid stagnation.

D2

13. Enter below your time schedule of reclamation activities that meets the requirements of Section 48-19-70 of the South Carolina Mining Act.

Permit # \_\_\_\_\_

## RECORD OF OPERATOR'S PLAN AND PROGRESS

Reclamation Practice	Segment # or Area	Planned **		*Applied		Notes
		Amount	Year	Amount	Month and Year	
Total Reclamation	A	20.2	9/91			
Total Reclamation	B	49.1	9/93			
Total Reclamation	C	41.6	9/93			
Total Reclamation	Leach Pad & Ponds	9.4	9/93			
Total Reclamation	Pit Areas	15.3	9/93			

\*\*Event dates are based upon a facility start-up date of 9/89

\*To be completed by the Department.

## YOU ARE HEREBY NOTIFIED THAT:

- 1) you must file an application to modify the reclamation plan in the event actual reclamation varies from that set forth hereinabove, and

## YOU ARE FURTHER NOTIFIED THAT:

- 1) Section 48-19-100 of the South Carolina Mining Act provides as follows:

"If at any time the Department finds that reclamation of the permit area is not proceeding in accordance with the reclamation plan and that the operator has failed within thirty days after notice to commence corrective action, or if the Department finds that reclamation has not been properly completed in conformance with the reclamation plan within two years, or longer if authorized by the Department, after termination of mining on any segment of the permit area, it shall initiate forfeiture proceedings against the bond or other security filed by the operator under Section 48-19-130. In addition, such failure shall constitute grounds for suspension or revocation of the operator's permit, as provided in Section 48-19-120."

Signature of Operator or Authorized Representative

*Michael D. Duff*

D3

Date

4/5/89

Title

Vice President - Operations

SOUTH CAROLINA LAND RESOURCES CONSERVATION COMMISSION  
DIVISION OF MINING AND RECLAMATION  
2221 Devine Street, Suite 222  
Columbia, S. C. 29205

APPLICATION FOR A MINING PERMIT

"The South Carolina Mining Act," Sections 48-19-10 through 48-19-230, Code of Laws of South Carolina, 1976, as amended provides in part: "After January 1, 1975, no operator shall engage in mining without having first obtained from the Department an operating permit which covers the affected land which has not terminated, been revoked, been suspended for the period in question, or otherwise become invalid." (Section 48-19-40)

MINE

1. Name of Mine Barite Hill County McCormick
2. Name of Company Gwalia (USA) LTD.  
(Check form of business entity: Corporation ☒ Partnership ☐ Limited Partnership ☐ Sole Proprietorship ☐
3. Home Office Address 1675 South Broadway, Suite 2350 Denver Colorado 80202  
(Street-Address or P. O. Box) (city) (state) (zip code)
4. Permanent Address for Receipt of Official Mail same as above (name)  
(Street or P. O. Box) (city) (state) (zip code) Telephone \_\_\_\_\_
5. Mine Office Address \_\_\_\_\_ Telephone \_\_\_\_\_  
(city) (state) (zip code)
6. Location of Mine Between U.S. 378 and U.S. 221, off Road 30 South of McCormick  
State or County Highway or Nearest Town or City
7. Mine Manager Michael Drozd, Gwalia (USA) LTD.
8. Locate accurately on a county map, or draw a detailed sketch map of: (1) how to get to your local office and  
(2) how to get to the mine and attach to this application.

D4

## 9. If land is leased, complete the following:

- a. Name of lessor Not Applicable
- Lessor's address \_\_\_\_\_  
(Street Address or P.O. Box) (city) (state) (zip code)
- Lessor's telephone \_\_\_\_\_
- b. Date of lease \_\_\_\_\_

## A. GENERAL CHARACTERISTICS OF MINE:

1. Total acreage for which permit is requested. Acres owned 326 Acres leased 0
2. Materials mined: GOLD
3. Mining method: Hydraulic Dredge ☐ Self-loading scraper ☐ Underground ☐ Shovel & Truck ☒  
Dragline & Truck ☐ Other \_\_\_\_\_
4. Will blasting be a part of your operation? Yes ☒ No ☐
5. Present depth of mine 0 feet
6. Expected maximum depth of mine(s) Elevations: 350 feet MSL.

DS



Permit # \_\_\_\_\_  
B. DETERMINATION OF AFFECTED ACREAGE AND BOND:

1. Number of years for which permit is requested Five (5)  
(10 years maximum)

2. Total affected acreage:

a. Area used for tailings ponds or sediment control ponds	<u>0</u>	acres
b. Area used for stockpiles of unprocessed minerals	<u>5</u>	acres
c. Area used for spoil banks and disposal of refuse (exclusive of tailings ponds)	<u>110.9</u>	acres
d. Areas used for on-site processing facilities, stockpiles of processed minerals and access	<u>9.4</u>	acres
e. Area for excavation during the period of this permit	<u>15.3</u>	acres

or

If mining and reclamation are to be done by segments, estimate acres of segments: \_\_\_\_\_ acres x 3 = Not Applicable acres  
(Show these segments on Question 13 of reclamation plan and map)

TOTAL OF 2a THROUGH 2e 140.6 acres

3. Check acreage to be bonded: total affected acreage figure from B-2 equals acreage to be bonded.

<input type="checkbox"/> 0 - 4.99 acres (bond - \$2,500)	<input type="checkbox"/> 5 - 9.99 acres (bond - \$5,000)
<input type="checkbox"/> 10 - 24.99 acres (bond - \$12,500)	<input checked="" type="checkbox"/> 25+ acres (bond - \$25,000 or more)

4. Will this operation be covered by a blanket bond? Yes ☐ No ☒

If so, check the amount of blanket bond:

☐ \$2,500      ☐ \$5,000      ☐ \$12,500      ☐ \$25,000 or more

D6

C. PROTECTION OF NATURAL RESOURCES:

1. Describe the wildlife or freshwater, estuarine or marine fisheries in the area of the mining operation.

Please see attached "Environmental Survey Report,"

2. Is there a waste water treatment system at your plant or mine? Yes ☐ No ☒.

3. Is there a point source discharge from your plant or mine? Yes ☒ No ☐

4. Is there an air contaminant emission from your mine or plant? Yes ☒ No ☐  
Fugitive Dust Emissions

5. Do you anticipate pumping of groundwater? Yes ☐ No ☒

6. Describe methods to be used to prevent physical hazard to persons and to any neighboring dwelling, house, school, church, hospital, commercial or industrial building, or public road.

The mine location is remote. There are no potential physical hazards to persons or neighboring dwellings for they are beyond a one-half mile radius from mine activities.

7. Describe methods to be used to prevent an adverse effect on the purposes of a publicly owned park, forest, or recreation area. The mine location is remote. No adverse effect is anticipated on any publicly owned park, forest, or recreation area. Present U.S. Forest Service lands, adjacent to proposed mine lands, shall become property of applicant before mining activities commence. Nearby Lake Thurmond is a recreational lake and shall be protected from any mine pollutants from applicant's compliance with a NPDES permit.

8. Describe measures to be taken to insure against (1) substantial deposits of sediment in stream beds or lakes, (2) landslides, (3) acid water pollution on adjacent property.

Please see attached "Description of Mine Activities Report," Section 5.0: Hydrologic Design

9. Describe measures to be taken for screening the operation from public view.

The mine location is remote. No screening measures are planned.

D7

10. Attach one (1) copy of a map that contains the following: Please see attached "Description of Mine Facilities Report"
  - a. Outline of the area that will be affected during the number of years for which the permit is requested; Section 2, Figure 2.1
  - b. Present ownership of land immediately adjacent to the area to be affected as shown on county tax maps, surveys, or other reliable sources; Please see attached "Property Holdings at Barite Hill", Figure 2
  - c. Outline of planned pits or excavations; Drawing 190-1
  - d. Outline of areas for the storage of naturally occurring soil that will be suitable for the establishment of vegetation in the final reclamation; Drawing 190-1
  - e. Outline of planned areas for disposal of refuse, exclusive of tailings ponds; None
  - f. Outline of planned spoil banks; Drawing 190-1
  - g. Outline of areas to be occupied by peaks or ridges; Drawing 190-1
  - h. Locations of planned access and haul roads on the area to be permitted; Drawing 190-1
  - i. Outline of planned tailings and sediment control ponds; Drawing 190-1
  - j. Location and name of streams and lakes and existing drainage ditches within the area to be affected with arrows indicating the direction which the water flows in such streams or ditches; Drawing 190-1
  - k. Outline of areas on which temporary or permanent vegetation will be established to control erosion during the mining permit; None
  - l. Outline of areas for stockpiles of unprocessed minerals; Drawing 190-1
  - m. Outline of area of previously mined land that will not be affected; None
  - n. Outline of the area to be occupied by processing facilities including stockpiles or processed minerals, if such facilities are to be an integral, on-site part of the mining operation; Drawing 190-1
  - o. A legend showing the name of applicant, the name of the proposed mine, the north arrow, the county, the scale, the date of preparation, and name and title of the person who prepared the map. Drawing 190-1

The required map shall have a neat, legible appearance and be of sufficient scale to show clearly the required information. The base for the map shall be either a specially prepared line drawing, aerial photograph, enlarged USGS topographic map, or a recently prepared plat, or a quality copy of any of these.

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Permit # \_\_\_\_\_

We hereby certify that all information and details contained hereinabove and on the map are true and correct to the best of our knowledge. We fully understand that any willful misrepresentation of facts will be cause for permit revocation.

11. The operator acknowledges that Section 48-19-100, Code of Laws of South Carolina, 1976, provides in part:

"Upon receipt of the operator's annual report or report of completion of reclamation and at any other reasonable time the Department may elect, the Department shall cause the permit area to be inspected to determine whether the operator has complied with the reclamation plan, the requirements of this chapter, any rules and regulations promulgated hereunder, and the terms and conditions of this permit. Accredited representatives of the Department shall have the right at all reasonable times to enter the land subject to the permit for the purpose of making such inspection and investigation.

Michael D. Dyer  
Signature of Operator or His Authorized Representative

Vice President - Operations  
Title

4/5/89  
Date

D. SUPPLEMENTAL INFORMATION REQUIRED BY THE DEPARTMENT; PURSUANT TO REGULATION 89-3 (for Department's use only):

E. ADDITIONAL TERMS AND CONDITIONS OF THE PERMIT REQUIRED BY THE DEPARTMENT (for Department's use only):

D10

TO BE COMPLETED BY DEPARTMENT

The foregoing application, together with the map dated \_\_\_\_\_, and the reclamation plan dated \_\_\_\_\_, are hereby approved. A permit for mining operation, conditioned upon mining and reclamation being performed as set forth in the application and plan and in accordance with the foregoing additional terms and conditions, will be issued upon the posting of a reclamation bond in the amount of \$ \_\_\_\_\_. No mining shall take place until a permit for the mining operation has been issued.

## LAND RESOURCES CONSERVATION COMMISSION

By: \_\_\_\_\_  
Division Director

Date: \_\_\_\_\_

NOTICE: You must file an application to modify the permit and reclamation plan in the event the actual operation varies from that set forth in the above-referenced application and reclamation plan.

## FOR OFFICE USE ONLY: )

Permit No. \_\_\_\_\_

Date Issued \_\_\_\_\_

Expiration Date \_\_\_\_\_

Renewal Date \_\_\_\_\_

Cancellation Date \_\_\_\_\_

D11

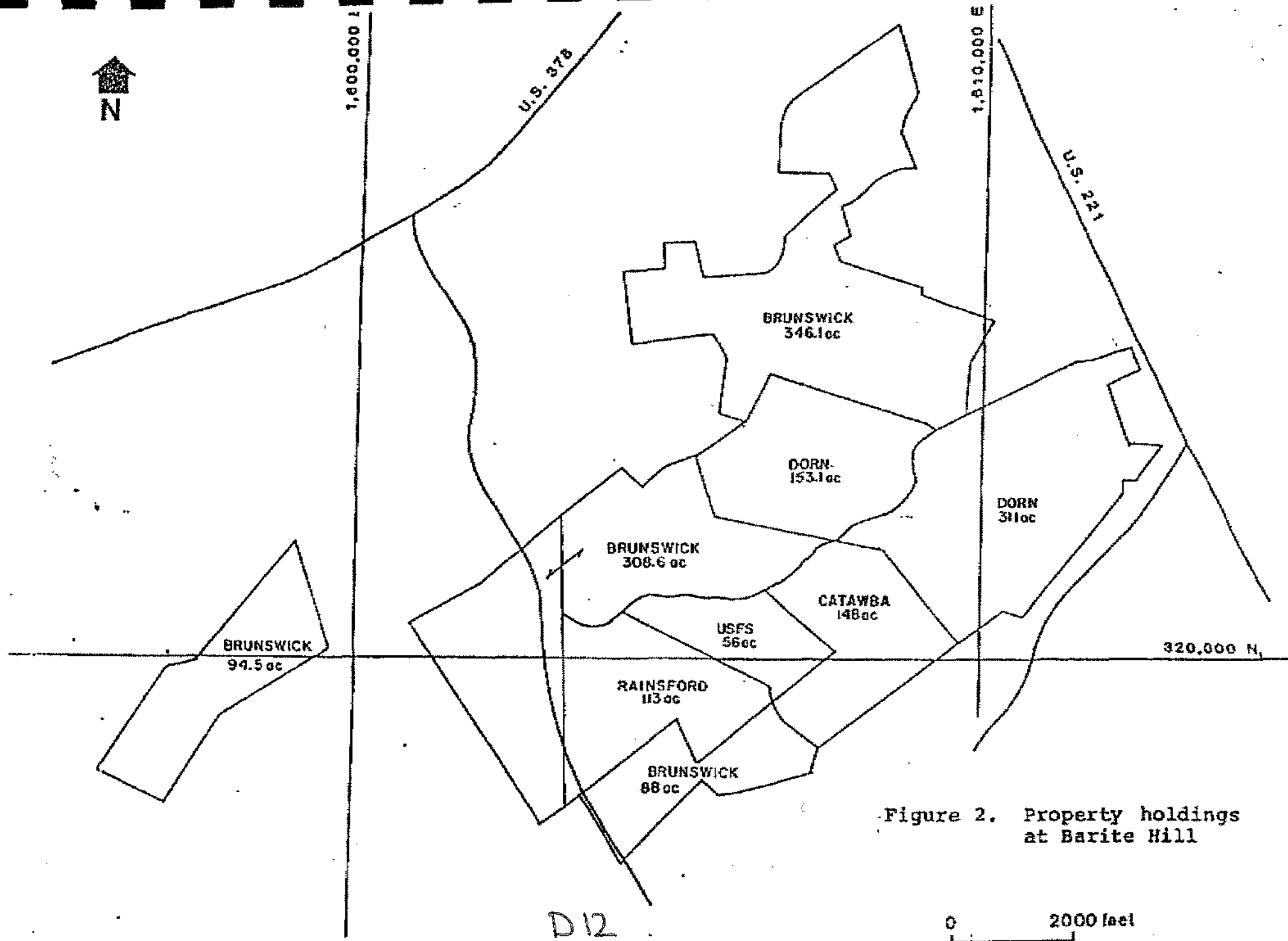


Figure 2. Property holdings at Barite Hill

SOUTH CAROLINA LAND RESOURCES CONSERVATION COMMISSION

DIVISION OF MINING & RECLAMATION

2221 Devine Street, Suite 222

Columbia, S. C. 29205

RECLAMATION PLAN

Permit Number \_\_\_\_\_  
(to be assigned by the  
Department)

1. Name of Mine Berite Hill Project  
County McCormick
2. Name of Company Gwalia Resources (International) LTD
3. Home Office Address 1675 South Broadway, Suite 2350, Denver  
(city)  
Colorado 80202  
(state) (zip code)
4. Permanent Address for Receipt of Official Mail \_\_\_\_\_  
(name)  
1675 South Broadway, Suite 2350, Denver, Colorado 80202  
(Street Address or P. O. Box) (city) (state) (zip code)  
Telephone (303) 592-4580
5. Mine Office Address 1675 South Broadway, Suite 2350, Denver, Colorado  
(city) (state)  
80202 Telephone (303) 592-4580  
(zip code)
- Location of Mine Between Hwy's U.S. 378 and U.S. 221, off Road 30, McCormick, S.C.  
(state or county highway) (nearest town or city)
6. Mine Manager Michael Drozd, Gwalia (USA) L.T.D.

D13



**APPENDIX E**  
**RECLAMATION SCHEDULE AND COST ESTIMATE**

NEVADA GOLDFIELDS INC.  
 BARITE HILL PROJECT  
 LAND DISTURBANCE, RECLAMATION SCHEDULE, ESTIMATED COST

SEGMENT	AREA DESCRIPTION	ACREAGE DISTURBED	YEAR OF RECLAMATION	RECLAMATION COST
A1	MAIN PIT	20.0	1995	\$ 15,165
A2	RAINSFORD PIT	6.9	1993	10,046
B1	PROCESS PLANT/PONDS	5.3	1996	33,729
B2	CRUSHING PLANT	2.5	1995	29,407
B3	REUSABLE LEACHPAD	7.0	1992	16,359
B4	ORE STOCKPILE	6.9	1994	8,475
B5	C AREA POND SYS.	5.4	1996	17,682
B6	OFFICE/SHOP AREA	3.1	1996	8,553
B7	C LEACHPAD-PHASE 1	6.5	1994	38,132
B8	C LEACHPAD-PHASE 2	3.4	1995	
B9	C LEACHPAD-PHASE 3	7.2	1996	
B10	C AREA POWER LINE	4.6	1996	3,340
B11	MAIN ACCESS ROAD	2.3		
B12	C DUMP HAUL ROAD	0.8	1992	UNDER C4
C1	A DAM AREA	3.9	1995	52,263
C2	A DUMP AREA	19.3	1995	
C3	A DUMP ACCESS	2.5	1995	
C4	SOLID WASTE AREA	6.7	1992	17,053
D1	MAIN PIT SED. POND	1.9	1995	4,713
D2	C AREA SEDIMENT POND	2.0	1996	
D3	C AREA SED POND #2	1.0	1996	
E1	A AREA TOPSOIL PILE	2.7	1995	6,015
E2	C AREA TOPSOIL PILE	1.1	1996	
E3	C AREA TOP. PILE #2	3.5	1996	
		126.5		\$260,932

reclaim-schedule-cost

E1

NEVADA GOLDFIELDS INC.  
BARITE HILL PROJECT  
LAND DISTURBANCE AND RECLAMATION SCHEDULE

SEGMENT	AREA DESCRIPTION	-----ACRAGE DISTURBED-----			YEAR OF RECLAMATI
		CURRENT	1992	1993	
A1	MAIN PIT	20.0			1995
A2	RAINSFORD PIT	6.9			1993
B1	PROCESS PLANT/PONDS	5.3			1996
B2	CRUSHING PLANT	2.5			1995
B3	REUSABLE LEACHPAD	7.0			1992
B4	ORE STOCKPILE	6.9			1994
B5	C AREA POND SYSTEM	5.4			1996
B6	OFFICE/SHOP AREA	3.1			1996
B7	C LEACHPAD (PHASE 1)		6.5		1994
B8	C LEACHPAD (PHASE 2)		3.4		1995
B9	C LEACHPAD (PHASE 3)			7.2	1996
B10	C AREA POWER LINE	4.6			1996
B11	MAIN ACCESS ROAD	2.3			1996
B12	C DUMP HAUL ROAD	0.8			1992
C1	A DAM AREA	3.9			1995
C2	A DUMP AREA	7.3	9.4	2.6	1995
C3	A DUMP ACCESS	2.5			1995
C4	SOLID WASTE AREA	6.7			1992
D1	MAIN PIT SEDIMENT POND	1.9			1995
D2	C AREA SEDIMENT POND	2.0			1996
D3	C AREA SEDIMENT POND#2	1.0			1996
E1	A AREA TOPSOIL PILE	2.7			1995
E2	C AREA TOPSOIL PILE	1.1			1996
E3	C AREA TOPSOIL FILE#2	3.5			1996
		97.4	19.3	9.8	

E2